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ECONOMIC GEOGRAPHY

OCTOBER

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Carol Y. Mason and Adagrace Rowlands
ANTHRACITE REGION OF PENNSYLVANIA
Raymond E. Murphy and Marion Murphy
ISLE ROYALE: POTENTIAL NATIONAL PARK
George H. Primmer
WATER PLAN FOR THE GREAT VALLEY OF CALIFORNIA
H. J. Wood
COTTON REGIONS OF MEXICO
Samuel N. Dicken
NORWAY'S INDUSTRIALIZATION
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SWINE INDUSTRY OF CHINA
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MINERAL WOOL INDUSTRY OF THE UNITED STATES
William D. Thornbury
BLUE MOUNTAIN COFFEE OF JAMAICA
Harry E. Hoy
SOME RECENT TRENDS IN ALASKAN COMMERCE
Willis B. Merriam
CHANGING FRONTIER IN THE COLUMBIA BASIN
Albert L. Seeman and Harold E. Tennant

LARK UNIVERSITY, WORCESTER, MASSACHUSETTS, U.S.A.

OUR CONTRIBUTORS

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PANAMA CANAL

IN THE great web of sea routes over which the commerce of the world is carried, which binds the nations of the world in economic ties not easily severed, and which forms the very foundation for international travel, transportation, and trade, the Panama Canal has become an ever more important strand as the years have passed since its completion. Like the Suez Canal it forms a focus of seaways, a node in the long line of maritime communication, important to the welfare and prosperity of most of the world's many folk.

It renders its greatest service as an instrument of peace, uniting the peoples of far distant lands into one economic family of nations. It draws the teeming millions of the densely settled lands of the Pacific Basin into close relationship with the other teeming millions of the Occident. It connects the shores and islands of the Pacific with the islands and shores of the Atlantic. The ships of all the nations slip through its docks bearing the flags of all the governments.

In time of war it becomes of critical importance, particularly to the United States. Then it must be defended from destruction, its passages must be kept open, its approaches must be safeguarded, that the American fleet may be united wherever and whenever necessity demands in one ocean or the other, and that the folk, the resources, the industries of the two coasts may be kept integrated and strong, both for offense and defense.

ECONOMIC GEOGRAPHY

VOL. 14 OCTOBER, 1938 No. 4

PANAMA CANAL TRAFFIC

Carol Y. Mason and Adagrace Rowlands

THE Panama Canal, opened in August 1914, brought San Francisco 7,873 miles nearer New York by water. Not only was the distance more than cut in half but the hardship of stormy passage through the famous Straits of Magellan was eliminated. Furthermore, the expense of transporting goods by water to the Atlantic seaboard suddenly became much less than it was by rail. California, Oregon, and Washington, long isolated from the industrial East, found themselves possessors of new markets not only in Eastern United States but in Europe, while manufacturers on both sides of the Atlantic could with profit in their turn send products to cities of the Pacific Coast. The accompanying graphs indicate the importance of this trade and show its growth and distribution, together with the increasing use of the Canal by foreign countries in many parts of the world.

Table I shows tonnage (in cargo tons of 2,240 pounds) of selected commodities shipped through the Canal in both directions in the three years for which the graphs are drawn. As noted in several places in the following pages, the figures used for the graphs do not coincide exactly with those of the table, for the two were taken from different sets of statistics. Both are from the "Panama Canal Record" published weekly or monthly in the Canal Zone.

TABLE I

TONNAGE OF SELECTED COMMODITIES THROUGH THE PANAMA CANAL

(in cargo tons of 2,240 pounds)

Statistics compiled from monthly totals given in the *Panama Canal Record*

	Atlantic to Pacific		
	1914–1915	*1924–1925*	*1935–1936*
Cotton	44,781	145,584	331,989
Petroleum and petroleum products	223,960	944,436	678,607
Coal and coke	299,508	255,345	132,956
Tin plate	24,280	.....	246,902
All metal (largely tin plate)	.....	206,933	.....
Scrap metal	.....	.....	646,464
Iron and steel manufactures	196,234	1,416,135	1,379,363
Machinery	32,788	133,024	137,261
Automobiles, trucks and accessories	.....	145,676	305,621
Paper and paper products	.....	107,998	392,065
All other	1,304,184	4,495,960	3,989,671
Total	2,125,735	7,851,091	8,240,899
U. S. Intercoastal	951,044	2,490,314	2,394,245
	Pacific to Atlantic		
	1914–1915	*1924–1925*	*1935–1936*
Nitrates	651,537	2,155,814	1,181,197
Petroleum and petroleum products	59,062	5,956,871	3,328,825
Iron ore	83,904	1,285,802	1,099,124
Copper and copper ore	67,729	(not differentiated)	438,700
Lumber (including manufactures)	179,341	2,255,421	2,764,091
Wheat	222,689	1,029,062	1,480,187
Barley	204,751	236,115	221,624
Flour	50,283	82,402	337,487
Canned goods	40,043	498,378	1,050,855
Fresh and dried fruits	.....	180,062	645,463
Sugar	277,776	211,168	1,391,909
Copra and coconut oil	.....	92,248	208,891
All other	1,006,942	2,217,698	4,107,691
Total	2,844,057	16,051,041	18,256,044
U. S. Intercoastal	895,614	7,019,126	5,137,065

The table, compiled from monthly statements of commodity tonnage, is accurate in detail, but the statistics for the graphs were compiled from weekly or

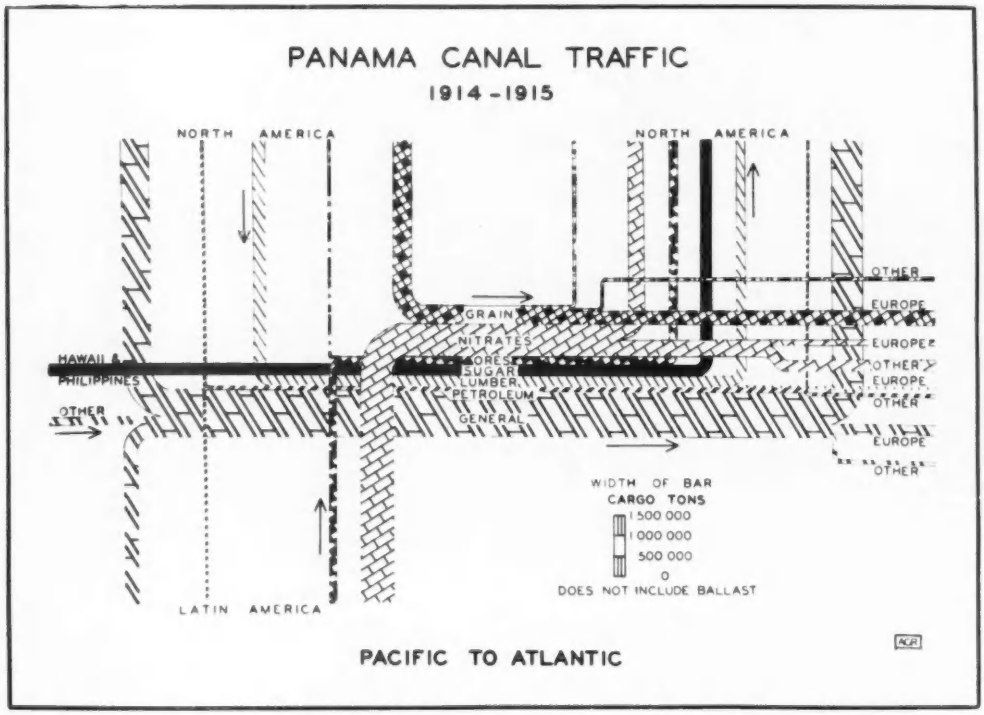

FIGURE 1.—Panama Canal traffic 1914–1915, Pacific to Atlantic.

monthly lists of ships, giving origin, destination, cargo, and tonnage of each vessel which made the Canal transit. Since cargoes are frequently listed in such ambiguous fashion as "lumber and general" or "general and canned goods" with no division of the tonnage, it will be obvious to the reader that strict accuracy in compilation of such data was impossible. The graphs should therefore be considered generalizations, and reference made to the exact statistics in table and text.

The writers make no attempt in so short a study to analyze or explain all changes in Canal traffic in relation to production, industry, land transportation, opening of new markets or sources of raw materials, or other conditions. They wish only to present certain facts and indicate a few salient points with regard to them, which may be of value. A brief analytical treatment of economic changes connected with the use of the Canal, emphasizing its relation to transcontinental rail traffic and especially to Canadian trade may be found in "Canada and the Panama Canal" by H. A. Innis, in the *Proceedings of the Fifth Pacific Science Congress, Canada, 1933*, Vol. II, University of Toronto Press, 1934.

TOTAL TRAFFIC

Trade in both directions through the Panama Canal was small in the first year, but producing areas and markets soon became adjusted to the change and increase in traffic was rapid. In 1914–1915 approximately 3,000,000 cargo tons passed from Pacific to Atlantic and 2,500,000 in the other direction. These figures do not include ballast. In 1924–1925, however, the totals had increased to 16,000,000 and 7,000,000 tons respectively. The peak was reached in the calendar year 1929 when the entire traffic of the Canal amounted to more

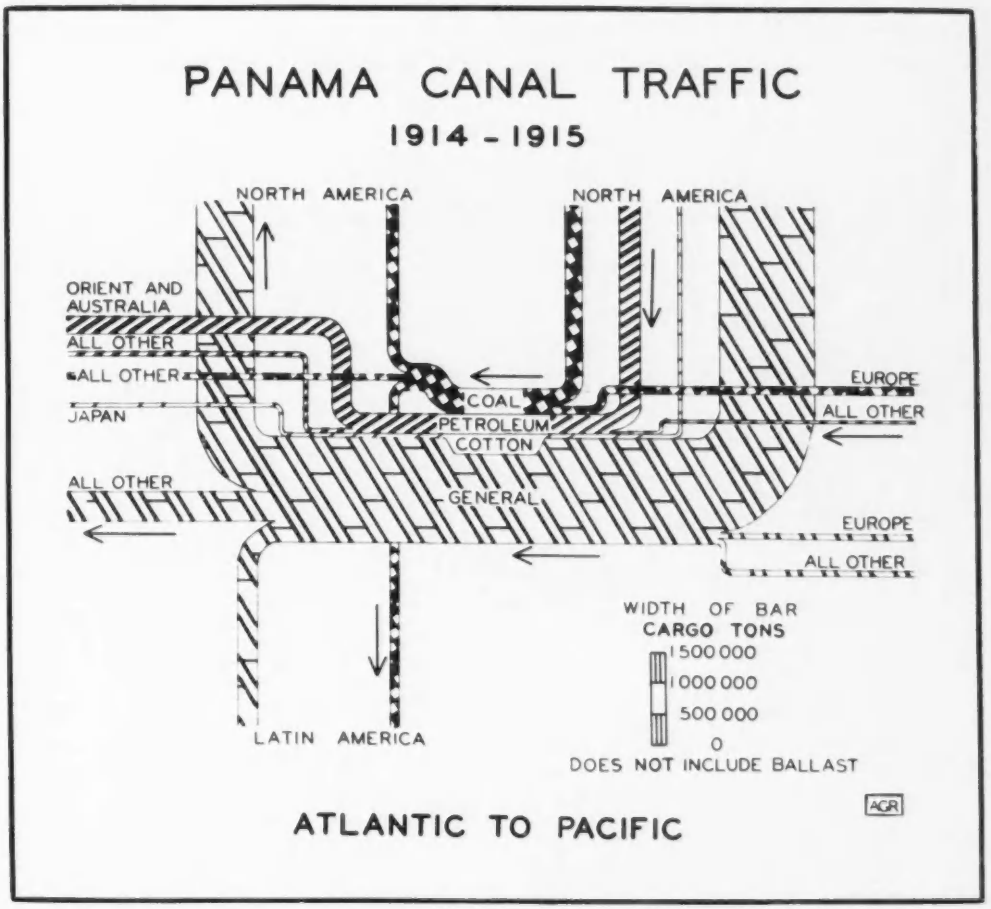

FIGURE 2.—Panama Canal traffic 1914–1915, Atlantic to Pacific.

than 31,000,000 tons, and with the economic depression it fell to 18,000,000 tons in 1932. Recovery has been less rapid, but in 1936 more than two-thirds of the loss had been made up, the total tonnage for that year reaching more than 27,000,000 tons. In the year 1935–1936 more than 18,250,000 tons passed from Pacific to Atlantic and nearly 8,250,000 tons from Atlantic to Pacific.

It is a conspicuous fact that from the outset tonnage from Pacific to Atlantic has been greater than that in the opposite direction. Bulky cargoes of raw materials and foodstuffs predominate going eastward while manufactured goods are more important in westbound ships. The difference was less marked at first but became increasingly noticeable for some years. Between 1924–1925 and 1935–1936, however, the proportions appear to have become fairly well stabilized.

Three groups of commodities predominate in the traffic passing through the Canal from Pacific to Atlantic. Lumber, petroleum, and so-called "general" cargo, which includes everything not classified under other headings, made up less than half of the tonnage eastward in 1914–1915 but rose to nearly three-fourths of it in both other years shown. In the west-bound traffic, however, "general" cargo is relatively more important, and together

with the group of ores, coal, iron, steel, machinery and other iron and steel products, makes up more than four-fifths of the tonnage in 1914–1915, nearly nine-tenths of it in 1924–1925 and approximately the same proportion in 1935–1936.

USE BY THE UNITED STATES

In 1914–1915, 43 per cent of the ships using the Canal were registered in the United States, and in 1924–1925 about one-half were in this group and carried more than one-half the cargo. In 1934–1935, however, only 40 per cent of the ships which made the Canal transit were of United States registry, and carried only 42 per cent of the cargo. In 1936–1937 the number had decreased to 31 per cent, carrying 37 per cent of the tonnage. Part of this decrease was the result of strikes at Pacific Coast ports, which caused almost complete cessation of intercoastal trade for more than two months. Because of the large United States intercoastal trade, all of which is carried in United States ships, the proportion of Panama Canal cargo thus transported is somewhat greater than the proportion of United States foreign trade carried by vessels of United States registration.

Table II shows that the United States accounts in all for more than 60 per cent of the total Canal tonnage. In 1934–1935, 33 per cent of the cargo was United States intercoastal traffic, and more than 28 per cent was United States foreign trade. In 1936–1937 although the United States intercoastal trade had decreased to 22.5 per cent the United States foreign trade had increased to 38.5 per cent, with the total the same. Thus the Canal is of greater importance

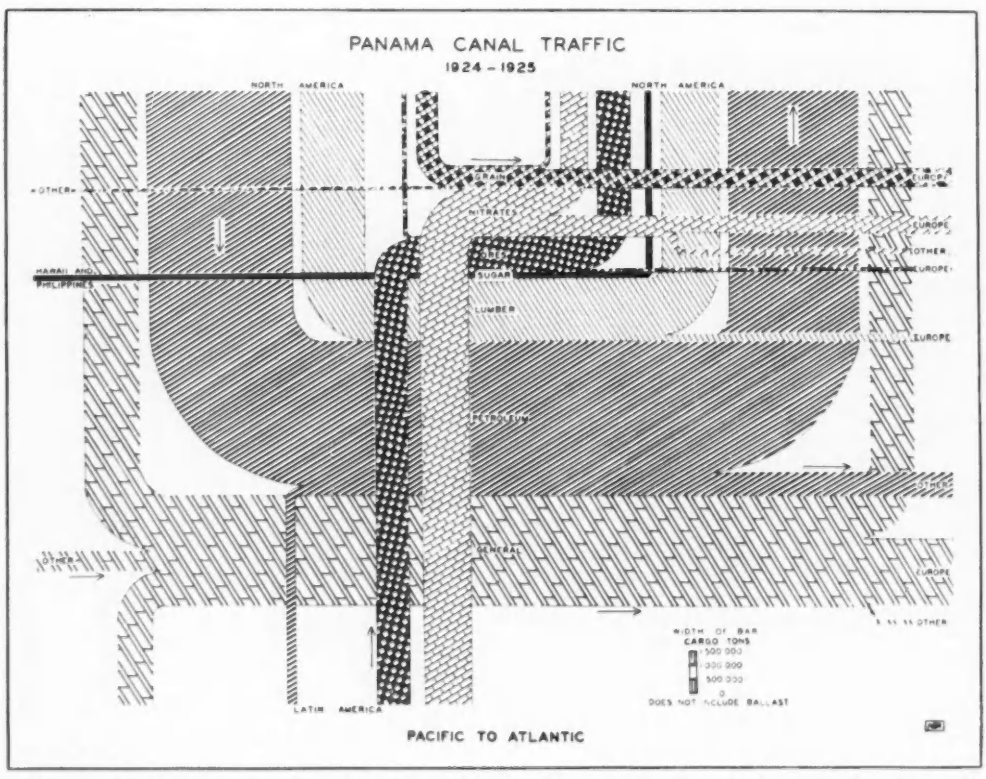

FIGURE 3.—Panama Canal traffic 1924–1925, Pacific to Atlantic. Grain and nitrates partly included in "General." (See Table I and explanation in text.)

TABLE II

UNITED STATES TRADE IN COMPARISON WITH TOTAL PASSING THROUGH CANAL, 1936–1937

Statistics compiled from monthly totals given in the *Panama Canal Record*

	Atlantic to Pacific		*Pacific to Atlantic*	
	Cargo Tons	*Per Cent of Total*	*Cargo Tons*	*Per Cent of Total*
U. S. Intercoastal	2,463,391	24	3,979,457	21
U. S. Foreign trade	4,481,989	45	5,978,045	32
Total traffic	9,895,632	100	18,212,743	100

Both directions: U. S. Intercoastal 22.5%. U. S. Foreign 38.5%. Total U. S. 61%

to commerce of the United States than to that of any other nation in the world. In addition to its commercial value, the Canal has tremendous strategic importance in making it possible for the United States Navy to move the fleet from Atlantic to Pacific.

COMMODITIES EASTBOUND

In 1914–1915 nitrates were the most important single commodity eastbound through the Canal and made up nearly one-fourth of the total cargo passing in that direction. While much of this went to southeastern United States, especially to Norfolk, Virginia, more than one-half went to Europe and other destinations. Shipments of nitrates increased rapidly, as they were much used for fertilizer in the leached soils of the United States Cotton Belt, and larger and larger percentages of Chilean shipments went to ports of that region. Europe, with the removal of wartime bar-

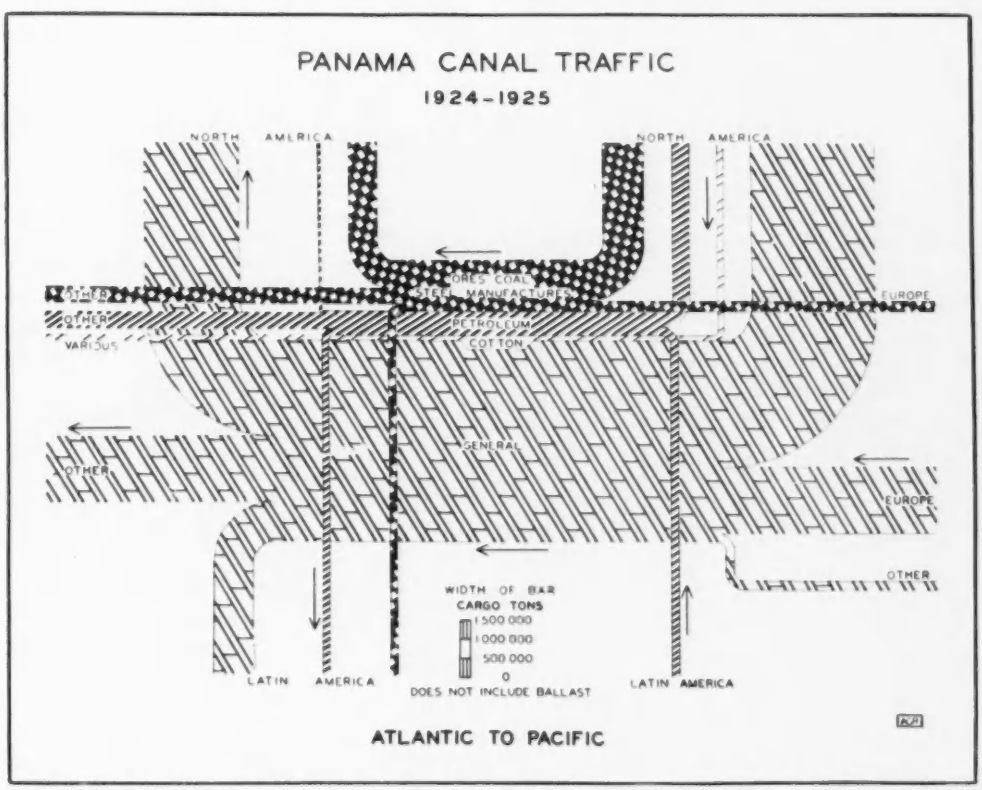

FIGURE 4.—Panama Canal traffic 1924–1925, Atlantic to Pacific. "Ores, coal, steel, manufactures" includes coal and coke, ores, metals, iron and steel manufactures, machinery and vehicles so listed in the classification of cargoes. 800,000 tons of these commodities, undifferentiated in the list of cargoes, have been included in "general."

riers to trade, imported increasingly large quantities of South American nitrate. Other cargo through the Canal increased so greatly, however, that in spite of the larger tonnage nitrates in 1924–1925 made up only about one-eighth of the total.

Imports of Chilean nitrates into the United States reached a maximum in 1928. Since that time, with the increasing production of synthetic nitrates, most of the great powers of the world have become nearly self-sufficient in them, and Chilean production has dropped tremendously. The economic depression accentuated this drop, and although there has been some increase in United States imports since 1932, the tonnage passing through the Panama Canal in 1935–1936 was only slightly more than one-half what it was in 1924–1925. Because of the increase in tonnage of all commodities, nitrates with a little over 1,000,000 tons had shrunk to about 6 per cent of the total, the smallest item worthy of separate mention except sugar.

In 1914–1915 lumber was an unimportant item in the trade from Pacific to Atlantic Oceans. For ten years prior to the opening of the Canal production of softwoods in the North Pacific Coast area remained fairly stable at between 5,000,000 and 6,000,000 board feet. Between 1915 and 1920, however, it rose to 9,000,000 and in 1926 to 12,000,000 board feet, two-thirds of which went to Eastern markets and one-sixth of which was exported. Much, though not all, of this passed through the Canal, making lumber a significant proportion of the Atlantic-bound cargo. In spite

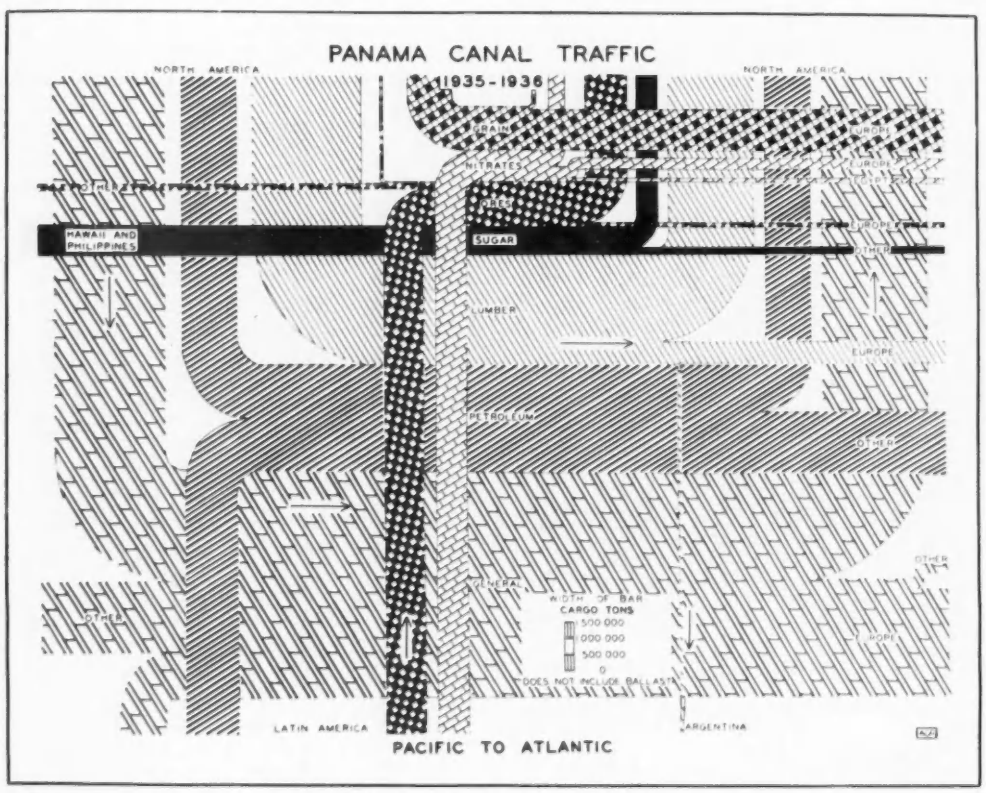

FIGURE 5.—Panama Canal traffic 1935–1936, Pacific to Atlantic. Some sugar, including that of United States intercoastal trade, is included in "general." Lumber includes logs, mill products, and some general products. (See Table I and explanation in text.)

of the great decrease in total production on the Pacific Coast as well as in Eastern timber producing regions since the late 1920's lumber shipments through the Canal have remained high, being more than half a million tons greater in 1935–1936 than in 1924–1925. The Pacific region in 1934 supplied 20 per cent of the lumber consumed in states east of the Rocky Mountains, and Canada, which in 1924 shipped more than 10 per cent of the forest products passing through the Canal, still sends an important part of the total.

Unfortunately the statistical source upon which the graphs are based includes many cargoes of "lumber and general" which are not differentiated as to tonnage. Thus the graphs show distinctly more "lumber" than actually passed through. However, in 1924–1925 statistics in Table I show that logs and lumber shipped through the Canal made up 14 per cent of the total eastbound cargo, and in 1935–1936 made up more than 15 per cent, being slightly more than 2,750,000 cargo tons in the latter year, an increase of more than 22 per cent in tonnage in spite of the intervening depression. More than half of this in 1935–1936 is United States intercoastal trade, but much lumber is exported from the Canadian Pacific coast and a substantial amount goes to Europe. A few small shipments to Argentina are of interest.

Grain has consistently made up a small percentage of the tonnage passing from Pacific to Atlantic. Although some barley is shipped from San Francisco to Europe, most of the grain is Canadian wheat bound for European (including British) ports. The graphs show somewhat less grain than was actually shipped, and although the tonnage seems to have increased about 50 per

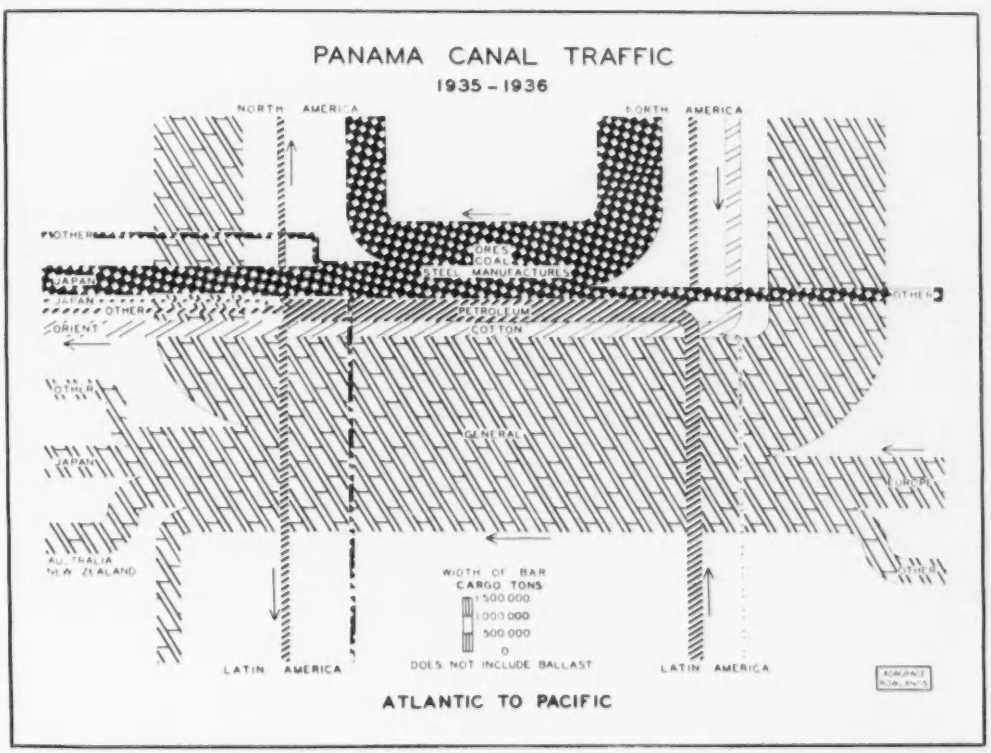

FIGURE 6.—Panama Canal traffic 1935–1936, Atlantic to Pacific. (See note under Figure 4.)

cent between the middle 20's and the middle 30's this is not indicative of the change between the periods as a whole, for the annual fluctuation of shipments is great. Canada does, however, ship considerably more wheat through the Canal than formerly, in part because of an adjustment of rail rates which makes it easier for Pacific ports to compete with those of the East.

Sugar is another of the major commodities passing through the Panama Canal. Since some of it was shipped as "general cargo" and not differentiated in the tables from which the statistics were compiled, the graph for 1935–1936 shows somewhat less than the 1,300,000 tons which passed from Hawaii, the Philippine Islands, and Pacific United States to Atlantic ports in that year. The bar extending toward Europe shows the new inclusion of European markets in the sphere of Hawaiian eastward shipments. Shipments of sugar through the Canal in 1935–1936 were more than six times as great as in 1924–1925, a fact which may be in part the result of tariff changes.

The total imports of sugar into the United States from Hawaii and the Philippine Islands increased considerably in the years just prior to 1934. The Smoot-Hawley tariff of 1930, which raised the duty on Cuban raw sugar from 1.76 to 2.0 cents a pound, caused an immediate slump in imports from that island, with a corresponding increase from Pacific sources. In 1934 the tariff on all sugar was reduced 25 per cent, and later in the same year a trade agreement with Cuba lowered that on Cuban sugar 40 per cent more, with the result that sugar imports from Cuban centrals increased 40 per cent between 1934 and 1935. At the same time imports from the Philippine Islands decreased slightly, since the United States in 1934 established a quota for Philippine sugar. Nevertheless the tonnage brought to Eastern ports in 1935–1936 through the Panama Canal did not return to its former low level, but still seems to reflect the shift in trade resulting partly from the 1930 tariff. Shipments in 1936–1937 were slightly greater than in 1935–1936, indicating a continuance of the new balance.

Ores and concentrates of various sorts come to the Eastern seaboard of the United States from South America. While copper and some others are included, iron ore from Cruz Grande, Chile, to Sparrows Point, Maryland, holds a dominating place in this trade, beside which others are relatively unimportant. Only a very small tonnage of ores and metals is shipped from the Pacific United States through the Canal, and a similarly small quantity goes to Europe. The increase in ores from "other" Pacific sources in 1935–1936 is noteworthy, and represents greater movement of such minerals as manganese, chrome ore, and antimony from Australasia and the Far East to the steel manufacturing districts of Britain and America.

Petroleum, which was to become the largest single item for many years in traffic from Pacific to Atlantic, was unimportant in 1915. Peruvian fields in that year shipped as much petroleum through the Canal as did those of California. In 1922, however, new oil pools were tapped in California at the same time that American imports from Mexico were rapidly decreasing, and the Pacific production began to flow eastward in great quantities. Additional pools discovered in the following year still further increased shipments. In 1924–1925 petroleum, a large proportion of which was California crude oil, made up 37 per cent of the entire tonnage through the Canal in the direction of the Atlantic. Nearly 6,000,000 tons

passed through eastward in that year, most of it going to Atlantic ports of the United States.

The shipments of California crude oil began to decline as early as 1924. With the development of the cracking process in the refining of oil, and with the enormous additional production of crude oil both in Venezuela and in the Mid-Continent Field of the United States in the late twenties, shipments of that commodity decreased rapidly, and in 1930 California ceased shipping crude oil. California today is finding it difficult to market her petroleum products, and in 1935–1936 sent only a little more than 1,500,000 tons from her refineries through the Canal, a tonnage which was nearly equalled by that from Peru. While considerable quantities of the California production sought other destinations than those on the Atlantic coast of North America in 1935–1936, a large percentage of Peruvian oil went to Nova Scotia. Petroleum products, including more than 1,000,000 tons of crude oil from South America, in that year made up only 18 per cent of the tonnage Atlantic-bound through the Canal.

COMMODITIES WESTBOUND

Petroleum passes through the Canal toward the Pacific as well as toward the Atlantic. In 1914–1915 shipments were almost entirely from the United States, and went chiefly to Oriental and Australian ports. This trade across the Pacific has now largely been taken care of from other sources, but petroleum still passes from Atlantic to Pacific in somewhat larger quantities than at first. Slightly more than a third now comes from the United States, and the remainder from Latin America, much of which is Venezuelan oil en route to Chile. In 1935–1936 petroleum tonnage was approximately 8 per cent of the total westbound through the Canal.

Cotton from Peru to Atlantic ports is so small in quantity that it has been included with general products, although it amounted to more than 100,000 tons in 1935–1936. But westbound cotton has increased from less than 50,000 tons in 1914–1915 to more than 300,000 tons in 1935–1936, being more than twice as much in that year as in 1924–1925 in spite of the economic depression of the early thirties. The percentage importance has also increased, as in 1935–1936 cotton made up approximately 4 per cent of the total Atlantic to Pacific tonnage, in contrast to its 2 per cent or less in the other two years. Before the World War of 1914–1918 Japan consumed only 2 per cent of American cotton, but between 1924 and 1929 the consumption was approximately 7 per cent. In 1933–1934 Japan took nearly one-fourth of the cotton which the United States exported, or about 15 per cent of the country's crop. The entire tonnage of cotton shipped toward the Pacific in 1935–1936 was only about three-fourths that which America sent to Japan in the earlier year. Furthermore, a small amount of cotton from Latin America to Japan makes its appearance on the 1935–1936 graph, reflecting the well-known increased production in Brazil. Of cotton in transit through the Canal in 1935–1936 practically all was bound for Japan, with only a very small quantity going to the Philippines and other Oriental destinations.

The group of commodities listed as "coal, ores, steel, manufactures" includes metallic minerals, iron, manufactured steel, and such products as machinery and automobiles. Since many manufactured products which should come under this heading are shipped in small lots, as part of "general cargo," the graphs show a much smaller total in this category than is given in the table, for every year. In 1914–1915 nearly

three-fourths of the tonnage shown in the graph and more than half that in the table was coal from the Eastern seaboard, chiefly Norfolk, Virginia, to Pacific ports of the United States, chiefly San Francisco, with some cargoes from Cardiff in Wales to British Columbia and Peru. In 1924–1925 a few cargoes of coal still moved from England and Wales to Pacific America, and many of coal and coke from Norfolk, Hampton Roads, and other United States ports to San Diego, Los Angeles, San Francisco, and Pearl Harbor in Hawaii. Steel and steel products had in the ten years become far more important than coal, however, going in large tonnages from New York and also from other North Atlantic ports chiefly to Pacific United States but to some extent to Canada and such more distant points as Yokohama and Singapore.

In 1935–1936 shipments of coal from Atlantic to Pacific states had dwindled to 62,000 tons, making up only 2 per cent of this group of commodities shown in the table, while iron and steel products comprised nearly 50 per cent. Iron and steel intercoastal shipments doubled between 1925 and 1929, then dropped sharply during the depression, but are again increasing, and in 1935–1936 were larger than in 1924–1925. Large tonnages of tin plate for north Pacific canneries formed a significant part of the whole group of iron, steel, and manufactured commodities. Shipments of automobiles doubled between 1924–1925 and 1935–1936, and became an important part of the group. In addition to the United States intercoastal shipments there were some cargoes of steel from Germany to Chile, and miscellaneous shipments to other regions. But the most important single item was scrap iron for Japan. Nearly 650,000 tons of scrap metal passed through the Canal in 1935–1936, and more than 1,600,000 tons in 1936–1937. A number of cargoes came from Europe, but most of them from the United States, from ports all the way from Searsport, Maine, to Galveston, Texas. A few cargoes were destined for Kobe or Yokohama, but nearly all were going to Moji, the port at the northern tip of Japan's southern island of Kyushu, near her most productive coal field. The whole group of coal, iron, steel, and various manufactured metal products made up nearly 35 per cent of the total Pacific-bound tonnage shipped through the Canal in 1935–1936.

General Commodities

Under the heading "general" have been grouped all commodities not sufficiently important to be treated by themselves. Since the statistics from which the graphs were made were obtained from lists in which items were not given in detail, the "general products" in the graphs include a much larger tonnage than in Table I. Nevertheless, in both cases the tonnage of general commodities passing from Pacific to Atlantic made up more than a third of the total in 1914–1915, decreased in proportion in 1924–1925 largely because of the huge shipments of crude oil from California, and had increased greatly in proportion to the total in 1935–1936. Proportional changes from Atlantic to Pacific also show similarities in table and graph. In that direction more than 60 per cent of the total was "general" in 1914–1915, there was comparatively slight change in proportion in 1924–1925, and a definite decrease in percentage of this group between 1924–1925 and 1935–1936. Quantitative as well as percentage changes correspond in the two presentations. Whereas in the case of eastbound cargo the total tonnage of "general products" has shown increase, with more in 1935–1936 than in 1924–

1925 in spite of the depression, the westbound "general commodities" were somewhat less in 1935–1936 than in the 11 years previously.

In 1914–1915 a large part of the "general" tonnage from Pacific to Atlantic was United States intercoastal traffic, but some went from Chile to Europe and a little from China to New York, among the miscellaneous other routes. In 1924–1925 while considerable came from South America to Europe, and some from the Orient to the United States, about one-half of the general commodities originated on the North American Pacific Coast, largely in United States ports. Much of this was intercoastal traffic, but a great deal also was made up of shipments of California products, especially fruits, and canned fish from Washington, to European ports.

When the Panama Canal was opened in 1914, lower freight rates to the Atlantic opened many new markets, both United States and European, to California producers. On some products freight rates through the Canal were much less than half those by railroad, from Pacific to Atlantic coast. One writer estimates that on a shipment of nearly 700,000 tons of canned goods in a single year in the late 1920's the shippers saved several million dollars in freight. Now, in 1938, the Canal tolls have been decreased, and it is possible that freight rates may be decreased again, giving Californians a still wider market by making possible lower prices. For many years the tolls on cargo have been $1.20 a net ton of the vessel passing through the Canal. Since this is estimated by cubic capacity of the ship, the toll may be paid on a much smaller tonnage than that of the cargo actually carried, but nevertheless a ship of net tonnage 2,000 tons has heretofore paid $2,400 toll. On March 1, 1938, the new toll rates went into effect, by which a loaded ship pays only $.90 a ton, and one carrying ballast pays as before, $.72 a ton.

The effect of low freight rates by water to the Atlantic was in the past and will be in the future, to cause greater shipments by that route. Between 1924–1925 and 1935–1936 there was an enormous increase in general products through the Canal, with an increase in tonnage from all sources and to all destinations. The total was 75 to 100 per cent larger, with a greater proportion coming from the Orient and more also going to the Eastern coast of the United States. The West coast of the United States still furnishes approximately 50 per cent. Much of the increase in shipments was in intercoastal trade. Between 1929 and 1936 alone, when most products had not made up what they lost during the depression and intercoastal shipments of vegetables, textiles, and other commodities from the Pacific Coast decreased considerably, the very large increase in shipments of dried and canned fruits and only slightly less large increase in tonnage of canned fish, especially salmon, more than made up for other declines. Some other commodities increasing in quantity were metal manufactures, nuts, and fertilizers. Exports of fruit to Europe do not show the same increase, but are still large in spite of the depression. Including both foreign and intercoastal trade, the Pacific shipped nearly 650,000 tons of dried and fresh fruits and more than 1,000,000 tons of canned goods including fruit and fish through the Canal in 1935–1936. This was a 150 per cent increase over 1924–1925. Thus the Pacific Coast states are making use of the Canal for a variety of shipments, and making increasing use of it, in spite of the decrease in production of petroleum which was once the major item

shipped. Table III, which shows the United States intercoastal trade for the fiscal year 1936, indicates the variety and tonnage of products with which our Pacific states supply the Eastern seaboard.

TABLE III

U. S. INTERCOASTAL TRADE, 1936

(in cargo tons)

U. S. Shipping Board, Division of Shipping Research: *U. S. Water Borne Intercoastal Traffic by Ports of Origin and Destination and Principal Commodities.* Fiscal Year Ending June 30

Commodities	*Pacific to Atlantic*	*Atlantic to Pacific*
Canned milk	5,755	887
Salmon	16	....
Canned salmon	82,950	105
Canned fish	81,934	6,215
Fish and fish products	26,553	920
Animal and dairy products	21,634	15,088
Hides, skins and manufactures	27,640	1,670
Barley	5,584	91
Corn	650	2,529
Oats	19,307	1,462
Rice	1,074	8,255
Rye	....	90
Wheat	81,951	....
Wheat flour	271,921	3,656
Other grains	6,985	3,093
Oil cake and meal	10,166	12,077
Vegetables and vegetable products	199,995	152,926
Fruits	30,448	2,099
Dried fruits	170,622	698
Canned fruits	445,018	12,230
Nuts	32,375	13,693
Sugar	279,027	918
Rubber and manufactures	3,496	5,122
Naval stores	7	15,856
Tobacco and manufactures	687	7,032
Cotton, raw	16,767	842
Cotton manufactures	3,681	25,110
Wool and wool manufactures	37,191	2,590
Other textiles and manufactures	23,993	33,505
Logs and lumber	1,564,583	34,291
Paper stock and manufactures	222,839	116,879
Coal and coke	487	21,027
Petroleum products	1,031,104	127,172
Cement	27	3,536
Sulphur	59	136,034
Non-metallic minerals and products	59,472	64,016
Iron ore	12	7,864
Iron, steel and manufactures	7,850	907,821
Copper and manufactures	142,474	15,716
Machinery	4,357	41,887
Vehicles	303	75,999
Ores, metals and manufactures	17,756	9,772
Phosphates	402	2,774
Other fertilizers	32,125	33,534
Pigments, chemicals and m'f'rs	47,770	179,601
Miscellaneous	75,234	397,725
Total	5,094,281	2,504,407

Numerous other cargoes than those from Pacific America go to make up the total of general products from Pacific to Atlantic. In 1924–1925 some of them were cotton from Callao to Liverpool, coffee from Guatemala to Hamburg, copra from Cebu to New Orleans, and dyewood from Nicaragua to Chester, Pennsylvania. In 1935–1936 there were nearly 220,000 tons of copra and coconut oil from the far Pacific, many cargoes of frozen products from New Zealand to London, a good many general cargoes from Valparaiso to Genoa, some from Magallanes to Bremen, from various Oriental ports to Eastern United States and from Canadian ports to various parts of Europe, as well as a considerable tonnage between parts of the British Empire, as from Sydney to the United Kingdom, from Melbourne to Montreal, from Vancouver to London, and from Brisbane in Australia to Halifax, Nova Scotia.

General cargo from Atlantic to Pacific has always been the most important single item going in that direction. For many years the general cargo going to the Pacific was far greater than that toward the Atlantic, and only in the last few years, since the increase in variety and tonnage from Pacific North America, has the eastbound general cargo surpassed the westbound. In 1914–1915 about two-thirds of the total westbound tonnage through the Canal was "general," and half of it was United States intercoastal traffic. This reflects the dependence of California, Oregon, and Washington upon the industrial states of the East for manufactured goods of many varieties. In 1924–1925 the tonnage was several times as great as that of the earlier year. It included much United States intercoastal trade, and a variety of miscellaneous cargoes such as "general and automobiles" from Halifax to Brisbane, sulphur from Texas to Australia, paper and dynamite from Christiania to Arica, and one or two "general and lumber" from Iquitos to Callao, Peru.

General cargo from Atlantic to Pacific in 1935–1936 totalled less than

eleven years before, and with slightly different distribution. Somewhat less came from Europe, somewhat less went to the west coast of South America, and somewhat more went to Japan. The most conspicuous cargoes were those from New York to the Pacific coast of the United States, while there were also numerous ones from Germany to Chile and to Japan, and quite a number from British ports to Pacific Canada, Australia, and New Zealand. In this as well as eastbound general cargoes, the United States intercoastal trade increased between 1929 and 1936, in spite of the depression that intervened. Of 12 selected commodities, 5 decreased, but the increase in the other 7 more than made up for the loss. The largest increase was in vegetables and vegetable products. Nearly 15,000 tons of canned vegetables in 1935–1936 and nearly 16,000 in 1936–1937 passed through the Canal from Atlantic to Pacific, chiefly from one coast of the United States to the other. The second largest increase was in chemicals, while increased shipments of fertilizers were also important. Three hundred and sixty-two thousand cargo tons of phosphates, potash, and other fertilizers were shipped from Atlantic to Pacific in 1935–1936. One of the largest total intercoastal tonnages is that of paper and paper products, which has increased in shipments in recent years.

CONCLUSION

The enormous increase in total tonnage of shipment through the Panama Canal from Pacific to Atlantic in the early 1920's was caused by the great tonnage of crude oil from California. Nevertheless the 1935–1936 total tonnage was greater than when petroleum shipment was at its height, in spite of the tremendous decrease in that commodity. The increase in lumber, grain, and general products has served to offset the decline of petroleum. In tonnage from Atlantic to Pacific, general products in all years make up a larger proportion of traffic than in the other direction, because so much of the material is manufactured or semi-manufactured, going in relatively small quantities, and a single cargo may contain many different kinds of products. Total tonnage westward is far less than that eastward, for the same reason, since Atlantic-bound cargoes are largely grain, nitrates, lumber, ore, and petroleum. In Pacific-bound cargoes, small quantities of petroleum and cotton, a large tonnage of iron, steel, and metal manufactures of all sorts, form the only other significant items large enough to be grouped separately from "general."

The total tonnage through the Canal increased rapidly to 1929, fell sharply to 1932, but has again risen and is approaching its former level. United States intercoastal trade makes up only 23 per cent of the total tonnage (1936–1937), a smaller proportion than formerly. This is in part because of the decrease in petroleum products, in part because of strikes, but some commodities are being shipped between the coasts more than in previous years. The Canal is of increasing value to other countries, and it remains a vital link in the trade between our Eastern and Western seaboards. While percentages of commodities to and from other parts of the world have varied somewhat, there is no question that the United States benefits more from the Canal than does any other country, in both foreign and domestic commerce.

ANTHRACITE REGION OF PENNSYLVANIA

Raymond E. Murphy and Marion Murphy

IN EASTERN Pennsylvania the great geanticline formed by the folding of the Appalachians plunges to the northeast and the surface formations become progressively younger. This explains the presence of the coal measures which elsewhere in the Folded Appalachians have been eroded away. It is the occurrence of an unusually valuable type of coal that furnishes the key to the geography of the Anthracite Region (Figure 1). Structurally the area is similar to the Ridge and Valley country to the west and south, and the parallelism of pattern that results from the structure is characteristic of both. But the use made of the Anthracite Region is so different from that of the remainder of the Ridge and Valley area that it is beyond question a world apart.

It is a world of narrow valleys clogged by great mine buildings, vast piles of waste, and an intricate rail net (Figure 2). Crowded within it is a population of more than a million people. Here is not an agricultural landscape interrupted by sporadic evidences of mining, as is sometimes the case in mining regions. With the exception of the Wyoming Valley (the Northern field of Figure 1) the Anthracite Region has never been an agricultural land, and perhaps it never will be one. People first come to most of it with the definite purpose of mining coal, and coal mining today either directly or indirectly supports nearly every person in the region.

The Anthracite Region presents primarily a coal mining landscape, but the unusual value of the coal and the physical difficulties of mining it have resulted in denser settlement than is characteristic of most mining regions. It is unusual among coal fields, too, because the nearly parallel ridges have imposed upon the area a rigidity of pattern. Crowded northeast-southwest trending valleys alternate with unused, poorly forested ridges. The anthracite has been eroded from the anticlinal ridges and remains only in the synclinal valleys, so that intensity of use is set in sharp contrast to land that can be classed almost as waste. Mines and mining towns are strung along the valleys, threaded together by railroads and highways. Sometimes the towns are set so closely that they merge without a perceptible break in urban development. From the mine openings great piles of waste are growing. Some appear as symmetrical cones, but others, the great majority, are elongated with a trend similar to that of the ridges and like them tend to show evenness of summit level. On either side of the valley, where the coal seams come to the surface, great red and yellow gashes frequently streak the ridge slopes. Here crop falls and occasional stripping operations (Figure 3) have added their long vivid strokes to the picture. Even the small wigwams of the "bootleg" mines seem to carry out the linear pattern (Figure 4). Their ramshackle workings may be seen straggling along the line of coal outcrop on company land that is being held for future mining or, perhaps, is being attacked from below by regular mining methods.

Anthracite Towns

It is a peculiarity of this region that nearly all of the million inhabitants live in agglomerated settlements of one type or another. Very rarely do people live

in isolated houses, and in this sense there is no rural population in the Anthracite Region. The towns range in size from small "patches" to cities of 100,000 or more. Scranton, the largest, has nearly 150,000 persons.

The typical anthracite town is located in a valley since it must be near the mines which also are usually in valleys. The houses look old, not so much because they were built long ago as because they were cheaply constructed and have had rough usage. In the larger towns there are areas of brick and stone similar to those found in any industrial city of northeastern United States. But there are many blocks, too, of cheap frame construction. It is in the "patches,"

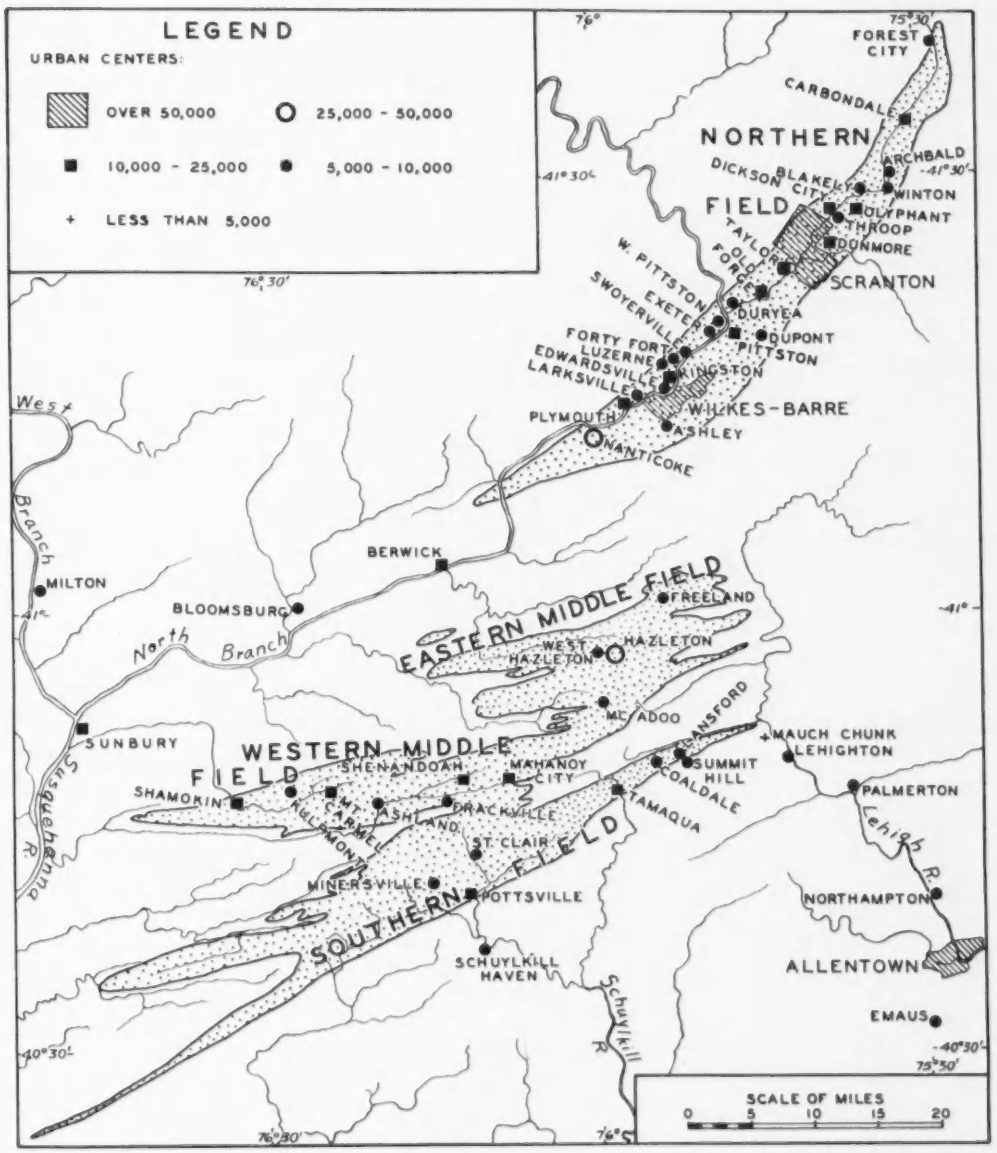

FIGURE 1.—The Anthracite Region of Pennsylvania. Dotted areas are underlain by the formations that contain anthracite. No attempt has been made to show the many population centers that are less than 5,000 in size.

however, that conditions become most bleak, for the "patch" usually consists of ten to fifty houses of miserable construction set facing one another along parallel streets (Figure 5). There are rows of them, absolutely uniform, sometimes painted but often presenting a surface of weather-stained boards that add their slate gray touch to the general monotony. The best houses of the smaller towns are those of company officials, though even these frequently are cursed by uniformity of structure and color. Here and there in the larger towns are the conspicuous modern homes of successful business men, but they only serve to emphasize the drabness elsewhere.

Dwelling in the houses of the average anthracite town is a great variety of racial types. Strange tongues may be heard on the streets and exotic foods may be found in the markets, for these towns have a cosmopolitan flavor. The mixed character of the population is evidenced, too, by the onion-shaped spires of the Greek and Russian Catholic churches that share the sky line with the simpler crosses of the Roman Catholic and Protestant spires (Figure 6). The complicated racial mixture of today can be broken down into several waves of immigration in the past. Upon an early groundwork of English, Welsh, and Scotch was laid a thick layer of Irish in the period between 1840 and 1870, and more recently Polish, Italian, Czechoslovakian, and Lithuanian groups have been added.

Encroaching upon the towns, intensifying the already crowded conditions, and occasionally interrupting the urban pattern completely are the mines of the Anthracite Region. Many types of mining occur, from the vast open pits of the "strippings" to complicated underground mines reached by shafts. But the shaft mine is by far the most common type since much of the coal has been carried far below the surface by folding of the rock layers.

FIGURE 2.—A typical crowded anthracite valley of the Western Middle field.

The typical shaft mine may be recognized by a headframe with its sheaves or hoisting wheels (Figure 7). Near by, at many mines, will be found the boiler house where power is generated which runs the hoists and other mine machinery. A great deal of power is used and part of the coal mined is converted into power to mine more coal, though this

FIGURE 3.—"Stripping" in the Western Middle field. Several "bootleg" mines are operating in the bottom of the strip pit.

practice is now giving place in many localities to the purchase of electric power. Usually a timber yard is a necessary adjunct. Here logs of various lengths and thicknesses, cut locally from the poor second growth or brought from other wooded areas, are stored preparatory to their use in the mine. At a distance, but still an essential part of the mine assemblage, is the ventilating shaft and fans. Here is carried on the vital business of forcing fresh air through the labyrinth of underground hallways and chambers. The most conspicuous mine building and the most universal is the breaker, for, regardless of the way in which the coal is dug from the ground, sooner or later it must go to the breaker to be prepared for market. These large, many-windowed structures are monuments to the care that must be taken in the preparation of anthracite. Some are new and modern, reminiscent of large factory buildings except that the breakers tower to much greater heights in proportion to their areal extent. Others are old, with their panes of glass broken. Many of them have been abandoned and allowed to slump; a great many have been torn down altogether. The status of the breaker tells much about the prosperity of the adjoining anthracite town. When the breaker is new the town bustles with activity; when the breaker is old or abandoned there are many men out of work and hard times last from one depression to the next.

Coal dominates the life of the average anthracite town. Not only do great waste piles and other mining forms frown down upon it, but the whole urban pulse throbs or ebbs with the status of the mining industry. The stores are busy in normal times for the miners have money to spend and believe in spending it. But when the mines are shut down there is a lifeless quality to the town. Here and there throughout the Anthracite Region are to be found ghost towns, mining communities that have died. Sometimes the breaker still stands, a monument to former activity; more often it has been torn down leaving the ghost town with little observable justification for its former existence.

FIGURE 4.—A "bootleg" mine not far west of Minersville in the Southern field. Illegal operations such as this, mining coal without permission on land belonging to one of the companies, are usually carried on by unemployed miners. Due to widespread local sympathy for the "bootleggers" the companies have been unable to obtain police protection against such activities. Note the small waste piles which, like ant hills, surround the crude headframe.

FIGURE 5.—Anthracite "patch" in the Western Middle field.

Even in the early days manufacturing accompanied mining in the anthracite towns. But the small blast furnaces, sawmills, and grist mills have been replaced by machinery manufacture and more recently by various aspects of the textile industry. In fact, textiles, particularly silk throwing and weaving, are far in the lead of all other types of manufacturing (Figure 8). Nearly every town of 5,000 population has its textile mill which employs cheaply the wives and daughters of the miners. Sometimes when the mine closes down the mill becomes the chief economic support of the town. Many of the textile plants are new, modern buildings with much window space, but often, too, old massive brick buildings form dark workshops for hundreds of employees. Next to textiles in importance but far less important is the manufacture of machinery for the mines and textile mills of the Anthracite Region. Most of the other industries are strictly service industries, furnishing the daily demands of the dense population.

Linking the whole region together and tying it with numerous cords to the outside world are the narrow- and standard-gauge tracks that form the arteries and veins of the whole unit. The number of railroads represented reflects the high value that has ordinarily been attached to the anthracite business. Eight companies share in hauling the anthracite. Six of them depend upon it as their chief item of freight. The railroads twist and turn, adjusting themselves to the rough topography. Occasionally a line expands into many parallel sets of tracks where vast tonnages of anthracite wait in gondolas for trains to be made up that will carry the coal to market. All this switching and carrying of heavy loads necessitates constant repair, and consequently railroad shops form another vital element in the landscape of the larger anthracite towns.

INTRAREGIONAL DIFFERENCES

Though the various features described are represented characteristically throughout the entire Anthracite Region, differing degrees of intensification and a few local exceptions result in interesting contrasts. Some areas were developed earlier than others, for example those near Carbondale, Mauch Chunk, and Pottsville. Particularly, those areas that were tapped by the Schuylkill and Lehigh rivers became important early, because canals were readily built that led directly to good markets.

By 1870 the Northern field or Wyoming Valley had outdistanced its more favorably situated southern rivals. There were several reasons for this. Although the Northern field was not the largest either in area or in original tonnage of coal, it was large enough to allow considerable room for development and it had coal enough to be well worth a great capital investment. But most important of all was the fact that the coal seams were shallower and more nearly flat-lying than those of any other part of the Anthracite Region (Figure 9).

Because there was an abundance of easily minable coal the Northern field has continued to be the scene of the greatest development. It has produced half of all the anthracite thus far mined in the state, and today it produces more

than half of the total anthracite tonnage and employs more than half of the miners. In the single, fairly wide lowland that constitutes the Wyoming Valley dwell more than half of all the people of the Anthracite Region. Here are the two largest urban centers—Scranton (143,000) and Wilkes-Barre (87,000)—and here, too, boroughs and small cities are so numerous that there are many miles of uninterrupted urban development.

Landscape forms associated directly with mining do not seem to be as crowded in the Northern field as in the others. The mines are set farther apart and there is more room for waste piles. Stripping is less important since outcrops are fewer, and this has served to discourage "bootleg" mining as well. On the other hand subsidence damage is more widespread in the Northern field than in the others, since great areas are underlain by seams that lie nearly horizontal not far below the surface.

The Eastern Middle field is in many ways different from the other three. Here a number of shallow, northeast-southwest trending synclines form many small basins with thick coal seams that are easy to mine. Erosion has not resulted in the marked ridge and valley country typical elsewhere, but has left the area standing as a fairly level plateau between valleys on either side. Here the towns, mine buildings, and waste dumps rise above the sky line like grain elevators on the Great Plains. Crowded towns are not so necessary as in other parts of the Anthracite Region, but the greater elevation, about 1,800 feet, results in a bleakness that becomes particularly apparent in winter. The many small synclines cause a patchiness of pattern which still, however, maintains something of the parallelism found elsewhere. Frequent outcrops give rise to many stripping operations and numerous crop falls which help to accent the linear quality of the landscape.

FIGURE 6.—Sky line of Mt. Carmel, a typical anthracite town.

In the Western Middle field the coal is deeper, underlying a topographic basin that is locally interrupted by low anticlinal ridges. Mining has not been very difficult, but on the other hand it has not been so easy as in the Northern and Eastern Middle fields. Because of the eastwest elongation of the field there is a long succession of good-sized anthracite towns: Shamokin, Kulpmont, Mount Carmel, Ashland, Frackville, Shenandoah, and Mahanoy City each has more than 5,000 persons. Numerous outcrops of coal have resulted in

many crop falls and "bootleg" mines. "Bootleg" tipples appear commonly along the highways and lumbering truck loads of "bootleg" coal help to clog the already overcrowded roads.

The Southern field is the largest of the four, both in area and in minable tonnage. It is a long topographic basin forking at the western end into what is known as the "fishtail." Although this field was the first to be extensively mined, its high degree of folding and faulting caused it to fall to third place as mining continued. Again, strippings, crop falls, and "bootleg" mines are common, but the greatest reserves of coal are far below the surface where they can be reached only by deep shafts. Since the field is long and narrow, parts of it are greatly congested: breakers, waste piles, towns, railroads, and highways all vie for space on the valley floors and on the lower slopes of the ridges. But the western end, the "fishtail," is thinly peopled, much of this land being held in reserve for future mining.

The most significant reflection of the degree of folding in the several fields is to be seen in the data pertaining to remaining reserves (Table I). The Southern field with its highly folded and faulted seams, though accounting for only one-eighth of the current production, has more recoverable coal than the other three fields together. The Western Middle field, though inferior to the Northern field in original tonnage, has been producing much more slowly and has a slightly greater reserve remaining. The Eastern Middle field with its easily minable coal and small original tonnage has the smallest reserves for the future, though parts of the Northern field are near the end of their mining history.

TABLE I

PRODUCTION AND RESERVE DATA FOR THE ANTHRACITE INDUSTRY OF PENNSYLVANIA IN NET TONS *

Field	*Production for 1935*	*Total Removed to Close of 1937*	*Recoverable Coal Remaining at Close of 1937*
Northern	28,244,204	3,068,635,000	1,821,611,000
Eastern Middle	5,248,176	506,056,000	94,676,000
Western Middle	11,946,398	1,369,245,000	2,102,416,000
Southern	6,530,040	1,112,228,000	4,928,332,000
Total	51,968,818	6,056,164,000	8,947,035,000

* Production data from Minerals Yearbook, United States Department of Mines. Data by fields are not available for a later year than 1935, but advance estimates show a total for the entire region of 54,760,000 net tons for 1936 and 50,037,000 tons for 1937.

Production to the close of 1937 and reserves then remaining are based primarily upon "Anthracite Losses and Reserves in Pennsylvania," Pennsylvania Geological Survey, Fourth Series, Bull. M–8, 1925. Figures given therein have been brought up to date by use of United States Bureau of Mines production data for 1922 to 1935, inclusive, and rough estimates for 1936 and 1937.

FIGURE 7.—Coaldale Colliery in the Southern field. The large building near the center of the picture is the breaker. To the left, on the hillside, are the headframe and power plant.

A PROBLEM AREA

It is an unfortunate fact that mineral regions, which seem to have so great a proportion of the earth's resources concentrated in so small an area, are seldom prosperous. Fertile agricultural regions nearly always demonstrate their wealth by their fine homes, good barns, and well-tilled fields. But mining regions, no matter what vast wealth actually comes out of the earth, are frequently poor. This is certainly true of the Anthracite Region of Pennsylvania. It was endowed with a unique and valuable resource amounting to a virtual monopoly, so much so, indeed, that today nearly 100 per cent of the anthracite produced in the United States comes from the four fields of Pennsylvania's Anthracite Region though they have an aggregate area of less than 500 square miles. Although

there are somewhat more than 100 anthracite mining companies at the present time, ten of these employ 70 per cent of the workmen and produce more than two-thirds of the coal. But in spite of its uniquely valuable resource the region was never prosperous, even in the days when anthracite was king of the fuels and monopolized both the industrial and domestic markets, and today it is a state and national problem area. Although the coal yielded by its mines has been estimated to be worth more than twice the value of all the gold mined in the United States from the beginning to the present day, it is a region of widespread poverty and large relief rolls, and the future seems gloomy indeed.

FIGURE 8.—A large plant for the manufacture of silk and rayon goods at Hazleton.

During many years of the industry's existence there were no competing fuels to worry about, and almost any price could be charged for the coal. But labor was not as easy to control as price, and increasing friction led eventually to disastrous strikes. In 1902 a strike occurred that affected the whole nation and was settled only after the intervention of President Theodore Roosevelt.

In spite of these difficulties, however, production increased steadily for nearly one hundred years until just prior to the World War when it reached 90 million tons per year (Figure 10). During the War there were two years when normal production together with the recovery of much fine-sized coal from the culm banks or waste piles of earlier days brought the annual total up nearly to 100 million tons. Then the total began to decline, slowly at first and more rapidly since.

The natural inference would be that the decline which has characterized the industry during recent years is due to exhaustion of resources. Locally this is true, but for the region as a whole no such simple explanation is possible. More anthracite remains that has already been mined, enough to last for one hundred or even two hundred years at the current rate of production (see Table I).

The chief cause of the decline seems to have been the rise of substitute fuels. Fuel oil, natural gas, low volatile bituminous coal, by-product coke, and to some extent hydroelectric power have invaded the former markets for anthracite, first in the industrial field and then later in the very field in which anthracite had been preëminent so long—domestic heating. The strikes of 1922 and 1925 have usually been credited with precipitating the invasion of anthracite markets by other fuels. Every time a user of anthracite was forced to try some other product there was the possibility that he might fail to return to the fold. The various competing fuels would certainly have invaded the domestic market sooner or later, but the struggle would have been more prolonged and the an-

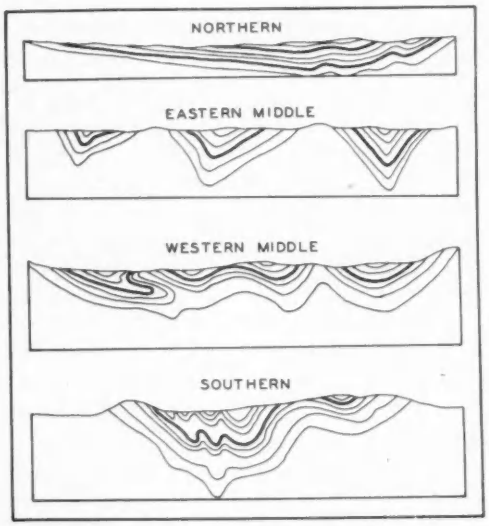

FIGURE 9.—Generalized northwest-southeast cross sections of the several anthracite fields showing approximate structure. A number of minable seams are involved, ranging in thickness from 50 feet in the case of the great Mammoth seam to as little as two feet.

thracite industry would probably be in a much better position today had it not been for the strikes. That labor became so highly organized in the Anthracite Region at an early date must be credited largely to the compactness of the region and the monopolistic tendency thus engendered.

Several other causes have contributed to the decline in demand for anthracite. These include a loss of our small export trade to Canada, an increase in the imports of Russian anthracite, and an increasing efficiency of heating equipment that makes it possible to use less fuel and to use the finer, less valuable sizes of anthracite. Piled upon the other difficulties with which the industry has been afflicted is "bootleg" mining. The companies have always allowed the miners to pick from the waste piles whatever coal they needed for their own use, but during the depression of the early 1930's when so many miners were out of work small openings were made where anthracite seams came close to the surface and the coal was literally stolen from the companies and sold below the normal market rate. This served to lessen materially the already diminishing demand for legitimate anthracite.

Accompanying the waning demand and production of anthracite has been a decline in employment. The number of men employed in the anthracite industry averaged 158,000 between 1920 and 1930, but in the last several years has averaged only about 100,000. In fact, this decline, slow to get under way at first but gathering speed as it progresses, is now more rapid than the downward drop of production. Mechanization has served here as elsewhere to aggravate a situation already trying enough. A steady increase in the proportion of all anthracite that is mined by stripping and a similar increase in the proportion of the underground production that is mined and loaded mechanically are reflected in an increasing output per man employed but in a decreasing employment total.

There have been as many cures suggested for the industry as there are ills. Some blame everything upon labor, and feel that the anthracite industry would recover easily enough if "bootleg" mining were stopped and strikes prevented. Others say that anthracite costs too much to mine and market and that if these costs were cut there would be a better chance of competing with other fuels. However, when the various items that go to make up the final price are analyzed it is difficult to decide just where to place the blame. The operators claim that labor costs are too great, and the wage rates paid are undoubtedly high as compared with those of many industries. On the other hand, taxes and royalties are probably excessive. It is charged, too, that some of the companies are overcapitalized with resultant heavy carrying charges. High freight rates

have been more commonly blamed. It is claimed by some that the mining companies can afford to take a loss year after year as long as the financiers who control them make a profit on royalties and freight rates. Such profits, of course, do the Anthracite Region little good, for they are spent outside the area.

A few practical steps have been taken. The anthracite operators now have an active organization which is attempting to popularize anthracite, to improve anthracite burning equipment, and to promote better marketing methods. There has been some talk of reducing freight rates, and a recent demand on the part of the railroads for a rate increase was rejected by the Interstate Commerce Commission. Finally, the annual spring price reduction was greater in 1938 than at any time during the last twenty years.

There has been considerable agitation in favor of state or federal intervention. Several courses are open. The government (state or national) could buy up the idle coal land—the reserves for the future—and thus relieve the present industry of a heavy tax burden. Or, the government could buy a limited amount of coal land and go into the mining business in direct competition with the already established mines, thus forcing them to mine more efficiently. Then, there are those who would like to see either the state or the nation take over the whole industry, but in this case it is feared that the new owner would necessarily inherit all of the problems that now face the industry along with an assortment of new ones. Any immediate move for government ownership, however, seems unlikely when one considers that there are powerful interests representing bituminous coal and petroleum, both in the United States as a whole and in Pennsylvania, that would naturally oppose aid being given to a rival fuel. The future seems not only gloomy but decidedly puzzling.

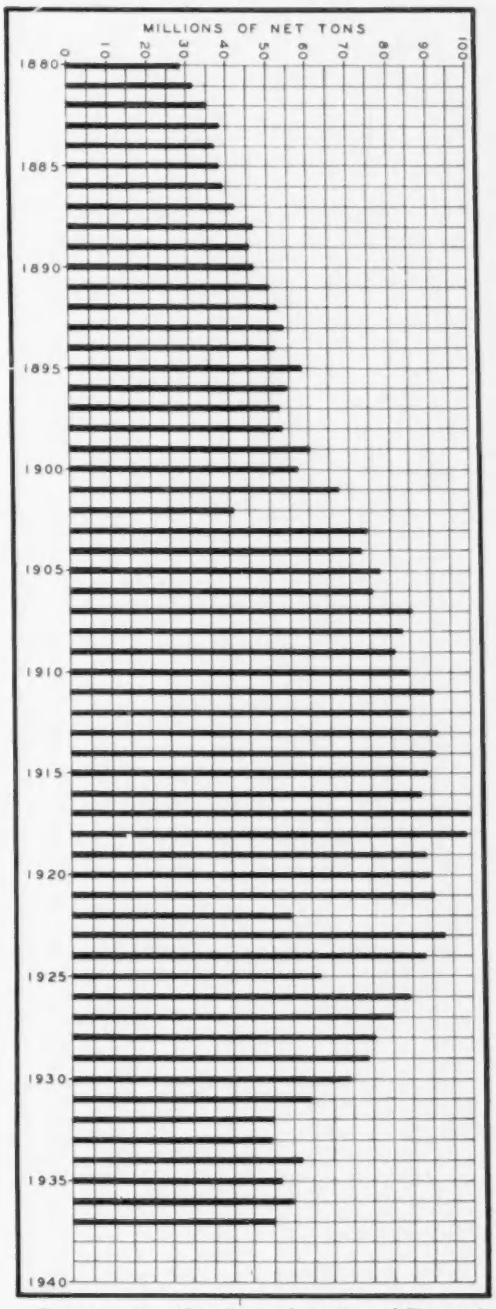

FIGURE 10.—The rise and decline of Pennsylvania's anthracite industry as shown by production. The strike years—1902, 1922, and 1925—are clearly apparent. (Data from *Mineral Resources of the United States* and its successor, the *Minerals Yearbook*, with advance estimates from the United States Bureau of Mines for 1936 and 1937.)

Viewed more broadly, what is the future of the Anthracite Region to be? Every mining area eventually grows old as its resources approach exhaustion, but this region has been undergoing a premature decline. Exhaustion of resources should not face the industry as a whole for at least another hundred and fifty years at the present rate of mining. Coal mines have been shut down while good reserves remain in the ground. Textile mills support mineless towns for a brief period and then suddenly migrate to the South, leaving a steadily increasing population surplus. Will the premature decline continue, or will the region be restored to the vigor its vast resources would seem to justify?

ISLE ROYALE: POTENTIAL NATIONAL PARK

George H. Primmer

WHAT constitutes proper material for a United States National Park? Its one-time president, Wallace W. Atwood, wrote of the National Parks Association that his organization "persistently worked for the preservation of all the superb natural wonderlands of this country that are especially valuable for scientific, educational, or inspirational purposes . . . endeavored to prevent any substandard areas from being included . . . tried to develop throughout the nation . . . desire on the part of all visitors to preserve, as far as possible, the primitive beauty of these areas."

Does Isle Royale fulfill the requirement of a superb natural wonderland possessing primitive beauty and value for science, education, or inspiration? Many persons so think; others, not at all unwilling to have the island receive full park status, consider it eligible on somewhat other than the usual grounds.

Eligibility for Park Status

Largest island in Lake Superior, though not largest in the Great Lakes, Royale measures big enough, a well-informed summer resident writes, for a careless camper to get thoroughly, dangerously lost (Figure 1). S. T. Mather, earlier director of National

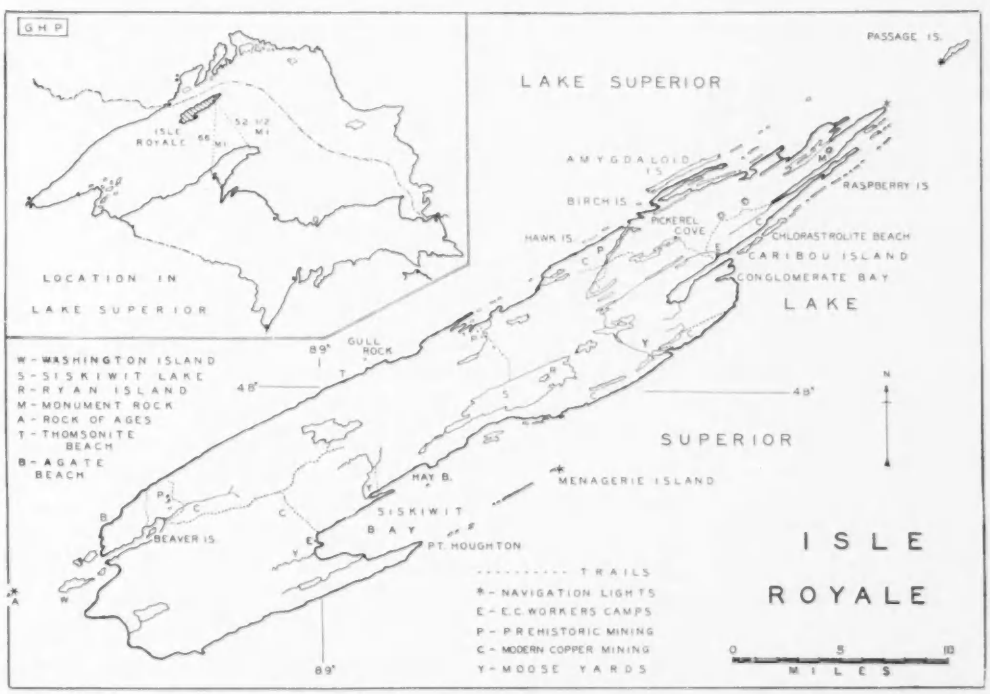

FIGURE 1.—Isle Royale sketch map. The island is forty-five miles long and three to eight miles wide, approximately two hundred square miles in area, and lies among one to two hundred small islets and projecting rocks, about fourteen miles distant from and parallel to Canada's mainland. One may reach Royale by traveling fifty-five miles from Copper Harbor, Upper Peninsula, Michigan, and nearly three times as far from Duluth-Superior.

Parks Service, aroused Isle Royale interest. He returned from a 1925 visit with pictures of moose and of scenery that made him think its royal name apt. Knowing its attractions first-hand, he waxed enthusiastic and showed himself more interested in Royale than in any other newly proposed national park. The federal government authorized Isle Royale park project March 3, 1931.

Persons first planning park status for Royale apparently considered it representative of all the upland lake forest areas of the three Upper Lakes states. Michigan mainland, Wisconsin, or Minnesota could furnish more typical examples. Isle Royale biota shows decidedly insular characteristics; flora differs from that of mainland in including but few Norway, white, and jack pines, few tamarack, and no hemlock. The fauna lacks chipmunks, raccoons, porcupines, woodchucks, bears, skunks, and deer. Once introduced, deer died out.

The once characteristic labeling Royale of national park caliber,—its wilderness condition, rare, next to uninhabited, and worthy of superior care,—many think more marvelous, and perhaps harder to maintain than more grandiose, more spectacular features of outstanding long-established parks. (Figure 2.)

INSPIRATIONAL AND SCIENTIFIC VALUES

Royale possesses three distinct types of scenic land forms: (1) bed rock protruding in ridges roughly paralleling the shore, (2) Lake Superior shore zone with many coves and offshore islands, and (3) about thirty inland lakes.

FIGURE 2.—Part of the eminently satisfying, though scarcely spectacular, Isle Royale scenery bordering Washington Harbor entrance. Viewed from Washington Island with Barnum and Booth islands showing north of the channel. The water is so clear that objects on the bottom can be seen through many feet of water as through plate glass.

Biologists readily find data on migration, dispersal, and intermingling of life forms; bog life history, from open lake to one carrying cedars or black spruce, stands fully illustrated, as do numerous fire succession vegetation stages.

Despite numerous contradictory reports extant, no caribou dwell on the island; the few possibly once present disappeared more than twenty-five years since, about the time moose appeared. Supposed evidence of caribou, based upon feeding marks, some now attribute to moose.

Moose numbers, never accurately known, likely reached one and possibly

FIGURE 3.—Lake trout caught by guests of Washington Island resort. Numerous commercial fishermen occupy shore cottages during the summer fishing season. In general fisherfolk plan retention of a life estate in lands transferred to National Parks Service.

two or three thousand in 1930 or soon after. Abundance at natural licks, some reinforced with salt blocks, led to exaggeration and over estimates. Browse depletion,—pondweeds, water lilies, ground hemlock, balsam fir, and mountain ash, especially,—led to plans for moose removal to mainland Michigan to help natural decline in numbers toward balance. One estimator suggested for 1937, four hundred and fifty, and another with more first-hand observation as a basis, thought the island then contained but two to three hundred moose.

Beaver, though reported wanting some years ago, appear numerous, and opportunity for abundant multiplication now offers. Rabbits, emergency food for early prospectors unwittingly wintering on the Royale, inhabit even the neighboring small islet. Shore gulls seem ubiquitous.

Royale waters support no bass, crappies, catfish, sturgeon, or carp. Savage Lake Siskiwit has big pickerel, which the conscientious call Great Northern pike; the less scrupulous, muskellunge. Mackinaw trout, of famed gameness and flavor, grow to thirty pounds in Lake Superior water slightly below 40 degrees Fahrenheit (Figure 3). Perch abound in the longitudinal lowland and fault line lakes; speckled trout prefer stream exits into Lake Superior; fishermen find northern pike about bay heads.

Geological values include: water-worn caves in north shore rocks with associated cliffs and skerries; distinctive con-

FIGURE 4.—Monument Rock, near northeast end of Royale, forms part of the attractive, but not grandiose, island scenery.

tour of differential rock wear; grooved, scratched, and polished ridges shaped by passing glacial ice with intermediate valleys in less resistant rocks, as certain amygdaloids; modern beaches, some with greenstones and thomsonites; and ancient beaches marking well in places lake levels at various Pleistocene stages (Figure 4).

Archeological values center about prehistoric copper miners, their mines, and ruined structures. One copper-bearing sedimentary belt, 20 to 40 feet wide, shows evidence of workings for two and one-half miles. Multitudinous "hammer stones" and numerous pits, 10 to 20 feet deep, indicate magnitude of operations; overgrowing cedars of 20-inch and pines of larger diameter indicate minimum time since abandonment. Recent finds indicate that the miners spent more than working days on the island; that they likely wintered at one head of canoe navigation point where a fall made water supply possible with minimum ice interference.

SCANT EXPLOITABLE ECONOMIC RESOURCES

Mining in the historic period followed close upon the 1843 cession from Indians. Two veins of one mine, worked until 1855, produced 150 tons copper. One old white chimney yet shows. A second mining period, 1871–1883, yielded around 10,000 tons copper; some of this came in masses of several thousand pounds each. A third producing era never materialized; a 1909 company planned extensive diamond drilling, but some twenty years later indicated willingness to give its 45,000-acre holding to help guarantee the proposed park.

Propagandist description of virgin forest growth, giant trees untouched by fire or woodsman's ax, leads one to wonder why lumbermen failed to despoil the island in the heyday of Lake Superior logging. Actually, an earlier generation of timber prospectors found the growth too stunted and, except near shore, too inaccessible to exploit. Small size of timber results largely from poor or shallow soil combined with a short, cool growing season in which residents consider 85 degrees excessively hot. In recent winters, logging crews have worked on thousands of acres cutting largely spruce of pulpwood size.

FIGURE 5.—Tree-clothed slope bordering Lake Superior waters. Fortunately for scenic values fires of recent years burned the interior rather than shore timber stands.

Much of Royale shows evidence of successive suffering from forest fire. Twenty-acre Ryan Island, Lake Siskiwit, most resembles primeval growth. Fortunately the three fires of 1933, though near shore, caused little loss in scenic value before extinction (Figure 5). Nearly one-third the forested is-

land lost its living green cover in a 1936 35,000-acre fire. Emergency Conservation workmen found a big task in cleaning débris from the burned-over interior. Conservationists hope to restore forest cover before run-off removes soil to increase appreciably the already considerable bare rock area.

SUMMER RESORT SITUATION

Many persons favoring park status for Royale apparently envision it a populous summer resort island. Those promoting the project to preserve an island wilderness area think the mainland of the lakes states can well serve most of the resorters seeking summer coolness; they hold that full resort development would spoil most of Royale's features that National Parks Service hopes to maintain.

In 1937 the federal government yet awaited acquisition of title to some 17,000 acres before establishing Isle Royale National Park. Tourists find the several resorts now on Royale readily accessible by boat from numerous points for four warmest months. One island establishment uniquely advertises not only fresh vegetables from its garden but fresh milk,—it owns the only Royale cow. Prospective plans contemplate continuance of such entertainment of visitors as Royale now offers (Figure 6).

FIGURE 6.—Resort hotel and cottages on a 283-acre island beside Washington Harbor entrance. No fire scars of consequence mar any part of the island for any recent time. Federal funds purchased this island, but, pending title transfer, the former owner has operated during summer of 1938.

Two boats serving the island from the north shore were lost in recent years, one from fire, the other from striking a Washington Harbor reef. Passengers experienced but casual inconvenience, for the current season will likely offer transport from Duluth-Superior, from other north shore points including Fort William-Port Arthur, and, with more commodious carriers, from Michigan "Copper Country" cities.

WATER PLAN FOR THE GREAT VALLEY OF CALIFORNIA

H. J. Wood

IN 1935 the Federal Bureau of Reclamation adopted the Central Valley Project of the California State Water Plan, evolved by the Division of Water Resources after a long period of investigation. Preliminary work soon commenced, and is proceeding, on a scheme that will have important results both in the near and distant future. It represents the triumph of efforts to overcome the limitation set to irrigation development by purely locally derived water supplies. The plan is based upon the great natural region as a whole. In view of these facts it is of interest to geographers to note the main features of its evolution and its major provisions.

The fundamental geographical unity of the Great Valley is familiar enough. It is a topographic depression occupying a great structural trough, almost completely surrounded by mountainous country. On its floor there has been, since the American occupation, a great development of irrigation involving increase of intensive farming. On the physical side this has been guided by topography, soil quality, and available water supply. It is with the latter that we are concerned here. Precipitation throughout the whole area of the river basins concerned is characterized by a winter maximum, and tends to decrease in amount, and increase in variability, from north to south. There is marked correlation with relief. In the loftier regions much of the precipitation takes the form of snow, and run-off is delayed until spring and early summer. This makes irrigation possible without storage, although it leaves the possibility of shortage in middle and late summer. The mean seasonal full natural run-off of the more important streams is given in Table I. The figures relate to the 46-year period 1889–1935, and are represented diagrammatically in Figure 1. They represent run-off at points in the foothills, mostly quite near the edge of the valley floor.

Figure 1 shows also in diagrammatic fashion the areas of irrigated land, excluding flooded pasture. It is at once apparent that there is a greater development of irrigated land in relation to available water supply in the south of the Great Valley than in the north. It has been estimated that the irrigated area in the Sacramento Basin as a whole was 206,300 acres in 1902, and 857,000 acres in 1929. For the region considered as a unit the limit to increase is not set by water supply factors. On the other hand, in the San Joaquin Basin there was an increase from 746,371 acres in 1899 to 2,430,156 acres in 1929,

TABLE I

SACRAMENTO BASIN

	River	*Acre-feet*
S.	Sacramento	8,806,300
F.	Feather	4,888,800
Y.	Yuba	2,500,500
B.	Bear	374,100
A.	American	2,873,800
	Creek	
S.	Stony	472,200
C.	Cache	.....
P.	Putah	.....

SAN JOAQUIN BASIN

	River	*Acre-feet*
C.	Cosumnes	378,800
M.	Mokelumne	804,300
C.	Calaveras	207,700
S.	Stanislaus	1,275,400
T.	Tuolumne	1,972,200
M.	Merced	1,055,200
S. J.	San Joaquin	1,891,100
K.	Kings	1,791,800
K.	Kaweah	420,300
T.	Tule	126,200
K.	Kern	686,200

(Data supplied by Deputy State Engineer.)

and in recent years much has been heard of water shortage, particularly in the southeastern sector. By way of further illustration we may note that census returns for 1929 show 277,407 acres irrigated directly from the Sacramento River, as against 222,363 acres irrigated from the Kaweah River. It will be observed from Figure 1 that the Kaweah full natural run-off is but a fraction of that of the Sacramento River at Red Bluff. Clearly the water supply of the Great Valley must be treated as a whole if local shortage is to be overcome and future expansion provided for. Moreover, it is obvious that the comprehensive planning involved will have to consider control of streams for purposes other than irrigation, notably for hydroelectric power development, flood control, and navigation.

What has been the past attitude to the notion of treating irrigation development in the Great Valley as a whole? In a Federal publication, "Report of the Board of Commissioners on the Irrigation of the San Joaquin, Tulare, and Sacramento Valleys of the State of California," by B. S. Alexander, G. H. Mendell, and G. Davidson, published in Washington as early as 1874, we find at least the will to plan on a large scale. At a time when irrigation was in an embryo stage the three authors state, in relation to the development they envisage as inevitable, that "It is all important that the works should be properly planned and located in the beginning, so that whatever is done to meet the present requirements of a sparse population may form a part of those that may be necessary to meet the demands of a population of millions by simply enlarging them." Works for the complete irrigation of the Great Valley they estimated as taking about fifty years to complete, and make a plea for the checking of development that might conflict with the system as a whole. As to this scheme, the merest diagrammatic sketch is provided. This shows major canals on each side of the Sacramento Valley leading from the river below Red Bluff, and a series of north-south canals linking the Sierra streams entering the Great Valley. Presumably the notion was to conduct water by stages from the northern region of plenty to the southern region of potential scarcity. It would of course have been miraculous if a practical scheme had been evolved at this date, with irrigation engineering in its infancy and basic data completely lacking. In any case a general plan involving a measure of control had no chance of acceptance at the time, and the chaos the authors foresaw duly appeared with increasing development.

The state engineer in a memorandum in 1886 gives no attention to the question of a unified plan of development, devoting his attention to the confused legal position of water rights and the need for some state regulation of water use. He states summarily that irrigation works in California cannot be made large unified systems. It is not until 1916 that a general water plan appears again, in the report of the State Water Problems Conference, appointed to recommend "a unified state policy with reference to navigation, reclamation, water storage, flood control, municipalities and drainage, with due regard to the needs of water power, mining and navigation." It is in relation to the disastrous floods caused by the Sacramento River that a plan is noted for a sidehill canal to carry flood waters from the vicinity of Red Bluff, along the western slope of the Sierra Foothills to the extreme south of the San Joaquin Valley, reservoirs for irrigation to be constructed en route, and ground water reserves increased by percolation. The Flood Control Committee of the House of Representatives

rejected the scheme as impossible practically and perhaps physically.

It was in the post-war period of economic optimism that there came to the fore an ambitious plan for unified development of the water resources of the Great Valley. It was described by its author, R. B. Marshall, who had had many years' experience in topographic surveying, as "one of the most clearly defined engineering projects ever proposed and at a cost so commensurately low that rapid and permanent settlement would surely follow." ("California's Greatest Opportunity. Reclaiming an Empire—the Valley of California," R. B. Marshall, 1919.) He estimated that development of 12,000,000 acres would be made possible, homes provided for 3,000,000 people, and problems of irrigation, floods, navigation, and water power would be solved. All the field data was at hand, construction could be carried through in ten years and, although the cost might be $750,000,000 California could handle big ideas, and the scheme would more than pay for itself. What was the Marshall plan? It was proposed to build a high dam across the Sacramento River near Red Bluff, and by means of large flanking canals to carry water down each side of the Sacramento Valley and into the San Joaquin Valley. The east side of the latter was to be supplied by long canals leading from the more northerly streams of greater run-off, the waters of the Kern River to be conducted by tunnel to the Los Angeles Basin. This loss of water to the Great Valley was to be compensated for by diversion of Klamath River water into the Sacramento Basin. Although the scheme received wide popular support technical opinion was skeptical at the outset, and finally it came to be realized that the plan was impossible physically, legally, and economically. It has interest as representing a repeatedly occurring phenomenon in the West, not entirely confined to the past. One great merit can, however, be claimed. Attention was directed to the need for impartial technical investigation of all aspects of Californian water resources and their use, and this was carried through in subsequent years by the state, in some cases with the coöperation of the Federal Bureau of Reclamation. The state water plan for the Great Valley bears no resemblance to the Marshall scheme, but its evolution can be traced to it. What were the main features of this evolution?

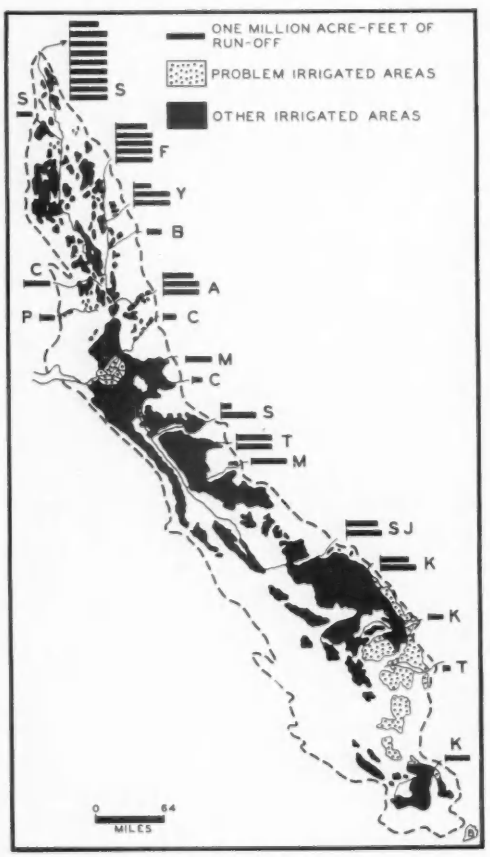

FIGURE 1.—Irrigation and average stream run-off. See Table I for key to initial letters. (Based on diagrams to be found in Bulletins 26 and 29, Division of Water Resources, Department of Public Works. Sacramento.)

The enquiries commenced in 1921 showed that far from data being avail-

able, many years of work would be needed. As this work proceeded the ideas put forward showed marked change. The report of the Department of Public Works, Bulletin No. 4, "Water Resources of California" published in Sacramento in 1923, outlines a preliminary comprehensive plan. It suggests that the east side lands of the Sacramento Valley should be served by diversion from adjacent streams, the main canals to be short, but that south of the American River five long canals should cross the existing canals in a southerly direction, in order to provide for the east side of the San Joaquin Valley. On the west side of the Sacramento Valley three canals would divert water from the Sacramento River towards the south and west, while the west side of the San Joaquin Valley would be provided for by a Grand Canal 200 miles long, with pumping plants, leading south from the delta region. This Grand Canal would derive its water from a reservoir behind a salt water barrier at Carquinez Straits.

A report published in 1925 shows fundamental change. ("Supplemental Report on Water Resources of California," Bulletin No. 9, Sacramento, 1925.) The southern end of the Great Valley is to have water diverted from the San Joaquin River at Friant. In order to replace water thus lost to users downstream from Friant, a supply is to be pumped up the San Joaquin River, *i.e.* a call is to be made on Sacramento supplies. To do this either a reservoir behind a salt water barrier is needed, or regulation of the Sacramento River in its mountain sector by means of a storage dam. Here in outline we see the basic element of the state plan that came to be finally adopted. Reports in 1927 and 1929 add further data, carrying investigations into more detail. In 1931 two volumes were completed which represent a great deal of work on water supply, surface and underground storage, water requirements, irrigation development, flood control, power development, land quality, etc., and contain an elaborate exposition of the Central Valley Plan. ("Sacramento River Basin," Bulletin No. 26, Sacramento, 1933; "San Joaquin River Basin," Bulletin No. 29, Sacramento, 1934.) Other bulletins dealing with regional problems in various sections of the state go to swell a list of investigations which makes California unique among western states in the scope and depth of its water inventory.

Before examining the Central Valley Water Plan we must note that only in part has it been shaped by general developmental considerations. It received great impetus because of its solution of two particular regional problems, at which we must now look. First, in the Sacramento-San Joaquin Delta, irrigation is liable to suffer curtailment in some years because of the invasion of salinity from San Francisco Bay. ("Variation and Control of Salinity in Sacramento-San Joaquin Delta and upper San Francisco Bay," Bulletin No. 27, Sacramento, 1932.) Second, on the east side of the upper San Joaquin Valley, particularly in the zone between the Kaweah and Kern Rivers, irrigation development is affected by water shortage.

The Sacramento-San Joaquin Delta is roughly triangular in shape, extending from Suisun Bay in the west towards Sacramento in the north and Stockton in the south. This flat, fen-like region, about 400,000 acres in extent, was once largely tule swamp liable to overflow, and has been reclaimed by stages over a period of seventy-five years. The agricultural utilization of this leveed region depends on the upkeep of a network of ditches and the use of pumps, and the larger channels divide the area into

"islands." Part of the delta is devoted to production of grain and hay and alfalfa, part to the intensive farming involved, for example, in trucking. Irrigation water is needed in summer, especially in July and August. However, there is a possibility of the water being saline in a varying proportion of the channels in dry years. The volume of water discharged into the delta between the years 1871 and 1929 averaged about 31,000,000 acre-feet, but there were fluctuations between extremes of from 6,000,000 to 80,000,000 acre-feet. About 80 per cent of the discharge comes between January and June, so that in any case the channels are at a low ebb in summer. If discharge is very low sea water invades the channels and makes irrigation impossible; the saline invasion is greater in the San Joaquin than in the Sacramento Delta and tends to remain longer. The problem is not entirely new, but low river volume in the years 1917, 1920, 1924, 1926, and 1931 focussed attention on the economic loss involved. The latter year provided a record up to that date, 70 per cent of the delta channels being affected. In the period 1920–29 there was a shortage of water for from one to three months in five years out of the ten. The aggravating factor has been a sequence of dry years with low run-off, but of course the development of irrigation upstream, both by direct diversion and storage, has steadily reduced water supply available in the delta. Not only has agriculture been affected but industrial establishments in the Antioch-Pittsburg area on Suisun Bay have been put to too heavy expense to obtain fresh water. What remedies have been suggested? The idea of constructing a salt water barrier at the delta entrance was suggested as far back as 1860. Between 1921 and 1929 detailed enquiries were made as to the feasibility of constructing a dam and thus maintaining a fresh water lake, to supply industry, municipalities, and agriculture, and to provide for export of Sacramento water to the San Joaquin Valley. Particular sites were considered and costs investigated. Finally the barrier scheme was rejected in favor of the control of stream flow at the headwaters of the Sacramento River, an integral feature of the state plan for the Great Valley.

FIGURE 2.—Fluctuations in estimated full natural run-off of Kings, Kern, and Kaweah Rivers, for seasons 1889–90 to 1935–36 inclusive.

The second regional problem has developed in the upper San Joaquin Valley, *i.e.* south of the transverse section of the San Joaquin River, on the east side. Here there has been great development in recent decades based on water derived from the Kings, Kaweah, Tule, and Kern Rivers, and to a small extent from White River and Poso Creek. Irriga-

tion of the alluvial fans is based on both canal and well and it is the latter type of use that has developed most rapidly. The result has been a lowering of the water table in several districts, especially in the zone between the Kaweah and Kern Rivers, and mainly in Tulare County. Water use has exceeded replenishment, and increased pumping costs due to deeper wells have coincided with economic depression and low prices. A series of dry years between 1925 and 1934 led to the problem becoming steadily more serious, and to increasing appeals for the adoption of a remedy. It is true that return to more normal precipitation and run-off provides amelioration in some areas, and that annual crops, *e.g.*, of cotton and grain can be adjusted to water supply available. This is not the case, however, where intensive fruit production is involved. Moreover, some localities have no remedy apart from importation from outside. They have been living, as it were, on their capital, and the fall in water table is permanent. This is particularly so in an interesting narrow foothill zone in Fresno and Tulare Counties, where relatively frost free conditions have led to the production of sensitive fruits, especially citrous. It will be of interest to glance at the main stages by which this problem of water shortage in the southern San Joaquin has reached the critical phase.

In the early years the use of ground water played a very inconspicuous part. The main use of wells in the latter part of the last century was, we are told, for the watering of stock. Their agricultural use seems to have been dictated in some cases by the absence of water right difficulties that so often arose where diversion from streams was involved. It was stated in 1912 that appreciation of economically justified pumping had only been realized in the previous decade. (Report of the Conservation Commission, Sacramento, 1912.) Beginnings had been made, and there were signs of rapid increase in the Fresno raisin grape area. Consequent lowering of the water table often had only beneficent results, *e.g.* in the Kings River Delta, because drainage was better and the menace of rise of alkali lessened. Significantly, however, it is noted that signs of lowered water table are seen in the foothill citrous fruit zone. In 1916 we are told that there was only faint realization of the value of ground water in the San Joaquin Valley and that surface supplies were generally cheaper. ("Ground Water in the San Joaquin Valley of California," Water Supply Paper 398, Washington, 1916.) However, from another source of the same date we learn that legal complications were arising from increased well sinking. (Report of State Water Problems Conference, Sacramento, 1916.)

Soon after the end of the war we find the problem of shortage coming to the fore. Development had speeded up under the stimulus of high prices. First comes an enquiry by the state Division of Engineering and Irrigation into conditions in Kern County, and then a report was made on Tulare County in response to a request for assistance made by water users. ("Water Resources of Tulare County and Their Utilization," Bulletin No. 3, Sacramento, 1922.) The latter, published in 1922, dealt with the deltas of the Kaweah and Tule Rivers and Deer and White Creeks. It is pointed out that the practice of using pumps tends to increase almost unnoticed. In 1909 Tulare County had 739 pumping plants; in 1919 it had 3,758. In 1920 and 1921 the mean net annual available water supply was being consumed in the Kaweah Delta, and "continuance without change of present conditions of diverting and pumping must eventually result in a reduction in

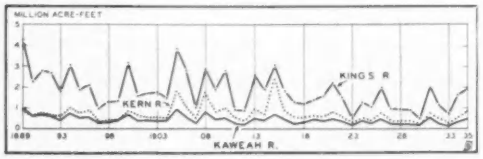

FIGURE 3.—Units of the Great Valley Water Plan. Other ultimate projected new or enlarged reservoirs are shown in black.

the areas now irrigated in some parts of the Kaweah Delta"; this owing to increased lift involving increased cost. The desirability of protecting developed lands before additional lands are brought under cultivation is stressed, and a suggestion made the position might be eased by local agreement to bring about some changes in water use. Of the Tule River area it was said that maintenance of conditions then obtaining could only lead to further lowering of the ground water table, and so, too, in other smaller tracts.

A state report with a wider region as the basis of enquiry was published in 1927. ("Ground Water Resources of the Southern San Joaquin Valley," Bulletin No. 11, Sacramento, 1927.) For the southern San Joaquin Valley as a whole, *i.e.* that section of the Great Valley south of that river, it was estimated that 800,000 acres depended wholly or in part on ground water, two and a half times the area so dependent in 1912. Of this total area "an area of about 180,000 acres is considered to be supplied from ground water sources where extent of present draft exceeds the average rate of replenishment of the supply." It is added that it is desirable that "additional development should not be undertaken unless a water supply for its permanent support is available." Of the aggregate acreage characterized by a falling water table it is noted that changes in use of stream flow would afford relief to about half, either by storage or by transfer of place of use of current canal diversions. Should the then conditions of use be maintained a developed area of 100,000 acres would eventually revert to waste land, the time when this would occur depending on the rate of lowering, and price levels in relation to pumping costs. It is interesting to notice that suggestions in this and other reports, pointing towards reorganization of water use to make the most of available supply on a maximum efficiency basis, and towards some sort of public control of new development, seem never to have had the least chance of acceptance.

The position became worse in subsequent years. On the basis of investigations brought down to 1929 it was stated that of 1,200,000 acres dependent on streams and wells in the upper San Joaquin Valley, some 400,000 acres were overdrawing. (Bulletin No. 29, Sacramento, 1933.) For the area as a whole only half the water needed for "full requirements" was available, although it must be remembered that much of the farming of the area had always to adjust itself to a variable supply. The report we are now considering estimated that without provision of more water in the future 200,000 acres would "revert to desert." There has been a not-unnatural tendency to assume, however, that all cases of land abandonment are due to water shortage, whereas economic depression should be given a place as a contributory factor. Low run-off from streams and falling prices in the years following 1930 led to some abandonment of irrigated land and a steadily increasing volume of outcry for the adoption of the state water plan for the Great Valley as a whole. A serious crisis was expected in the summer of 1935, but good run-off in the 1934–35 season, due to greater precipitation than had occurred for some years, made the outcome less gloomy than was predicted.

The improvement was maintained in 1936. Figure 2 shows fluctuations in estimated full natural run-off of the Kings, Kern, and Kaweah Rivers between the seasons 1889–90 and 1935–36.

The state water plan, worked out in its main lines by 1931, was adopted by California as a result of a referendum early in 1934, and its inauguration taken over by the Bureau of Reclamation in the following year. Its more important elements are shown in Figure 3. What are the main features of the initial plan, and what is projected for the more distant future?

The most immediate need is for greater water supply in the southern San Joaquin Valley and hence a dam is to be constructed at Friant, on the San Joaquin River, near the edge of the Sierra Foothills. The resultant storage will make possible the feeding of two major canals. The Madera Canal is to trend northwest for 35 miles towards the Fresno River, in order to supply an area at present liable to deficiency. The Friant-Kern Canal will lead southeast and south for 157 miles to the Kern River, crossing the Kings, Kaweah, and Tule Rivers en route, and promising to relieve deficiency in an extensive tract. Not only will there be more water for surface diversion but ground water storage will be replenished, thus raising the water table and reducing pumping costs. However, the construction of the Friant Reservoir involves reducing water available downstream on the San Joaquin, water upon which claims already exist, for present or future use. This must be replaced and will come from the regulated Sacramento River, via a Delta Cross Channel. Ultimately it is planned to construct the San Joaquin River Pump System to raise the water as far as Mendota, using in large part the present river channel. Regulation of the Sacramento River, and hence the presence of adequate water in the delta region at all times, will counteract the tendency for saline water to invade the channels in dry years, and also make possible the delivery of water to the industrial districts on Suisun Bay, by means of the Contra Costa Conduit. How is the Sacramento River to be regulated? A dam at Kennett, about ten miles north of Redding, will hold back the headwaters of the stream. This is the most expensive unit in the Water Plan, involving not only construction costs but the flooding of a large area and re-location of railway tracks.

Thus the waters of the Great Valley will come under a large measure of control, leading to transfer from areas of surplus to areas of deficiency, and tending to remove checks to development set by purely local water supply conditions. The plan has more than an irrigation function. The Kennett Dam will do much to control floods on the Sacramento River, long a source of danger and expense to developed lands, despite counter measures. It will be used too for a large development of hydroelectric power to be conveyed to the San Francisco Bay region, and much is hoped from the anticipated revenues. Navigation will be improved on the Sacramento River to Red Bluff, on the Feather River to Yuba City, and on the San Joaquin for 86 miles above Stockton. The latter involves the incorporation of locks in the dams proposed for the pumping system.

Not in the near future, but ultimately, the state of California looks forward to other developments to round off its Water Plan for the Great Valley. Greater regulation of the Sierra tributaries of the Sacramento and San Joaquin Rivers is looked forward to, too, by provision of reservoirs where none now exist, or enlargement of present storage

facilities. Thus will increased flood control be possible as well as augmented water supply. An extension of the San Joaquin Pumping System, south from the river near Mendota, is forecast as a method of bringing water to the semi-arid western side of the upper San Joaquin Valley, now largely given over to grazing. There is a proposal, too, to divert the waters of the Trinity River, in the Klamath region, to the Sacramento River above Redding.

So far we have sketched the evolution of the Great Valley Water Plan and outlined its main features. It remains to notice criticism. There is, of course, a complex legal situation in relation to water rights, especially in relation to diversion of water outside original river basins, and exchange of water, but this is not regarded as an insuperable obstacle. On the engineering side the plan involves some striking features, but although there may be modification of detail with further investigations there is an impressive amount of data behind the scheme. It is in relation to the economic aspects that legitimate doubts have been expressed. There is, of course, a large body of uncritical opinion in the west that is ever ready to be enthusiastic about schemes that involve expansion, although during economic depression the emphasis is put upon the relief work aspect, and the necessity to rescue areas in which large investments of capital have been made. The latter issue tends to be exaggerated for propaganda purposes. Much of the impetus behind any large-scale irrigation scheme comes from vested business interests that stand to gain from the resultant economic activity, whether ultimately the project as a whole shows profit or loss. These interests have great scope in a region of generally diffused economic optimism. It would be strange indeed if, in a state that has seen such remarkable expansion in recent decades, there was not a general assumption that despite temporary setbacks future expansion could be taken for granted. Whether or not the Water Plan is justified turns on future economic trends in the United States as a whole and in California in particular, and the appropriations made for economic investigation have been but a small fraction of those set aside for engineering. It is true that economic investigation is complex and difficult. It involves forecasts of population for nation and state, analyses of external and internal trade, the future of competing regions, the relative merits of intensive and extensive farming, the separation of short from long period tendencies, etc., etc. It is true that some work has been done on these lines, but problematical issues remain. Is the case for improved navigation of rivers nullified in view of experience elsewhere, and in view of the presence of excellent roads and railways? Can the projected large development of electric power at Kennett be absorbed in the near future? Will the more intensive farming that will result from a secure water supply lead to overproduction? Will steps be taken to control the bringing in of new land if there is no economic justification for it? Given a demand for more water, is there any certainty that it will be paid for, in view of past unhappy experiences in many irrigation enterprises? What of land in projects, still unused despite water facilities? Finally, should any large project be embarked upon until the problem of inducing land settlement has been solved? These questions are being asked by those interested in the Water Plan, and there is a lack of unanimity in the answers.

COTTON REGIONS OF MEXICO

Samuel N. Dicken

COTTON is the most important commercial crop in Mexico, second in value after corn. Six districts in the northern border states, Mexicali, Juárez, Conchos, Matamoras, Don Martín and Laguna (Figure 1), account for 90 per cent of the production; the remainder is widely scattered through a dozen states. Three major regions are on the international border, two depend on water from the Colorado and Rio Grande rivers. Five regions are irrigated oases and the system of farming is to be compared with that of the Salt River in Arizona, Egypt, and the Indus Valley rather than with the Cotton Belt of southeastern United States. The oases which make this cultivation possible are widely scattered from the Colorado Delta of Lower California to the Lower Rio Grande Valley of Tamaulipas; all are arid or semi-arid; the amount of precipitation increases from west to east so that less water is needed for irrigation. At Mexicali the average rainfall, three inches, is insignificant and the crop is grown entirely by irrigation while at Matamoras near the Gulf of Mexico with 30 inches, irrigation is desirable but not necessary. All of the regions are located on alluvial deposits but of varying quality; Mexicali is on a river delta; Juárez and Matamoras are on silty river flood plains; Don Martín is on a gravelly piedmont; Laguna and Conchos in part, are in broad alluvial basins partly lacustrine, between basin ranges. Production is highly variable; from a ten year point of view three regions, Laguna, Matamoras and Mexicali account for more than 80 per cent of the total production but the other regions are growing in relative importance.

It is particularly important to examine the background of production in these regions when so many important changes are taking place. The agrarian reforms are being pushed most rapidly in these areas and the large land holdings are being divided into small *ejidos* which are farmed by the *campesinos,* usually under government supervision. Concurrently new dams and irrigation systems are being constructed and new methods of cultivation introduced. Furthermore, coupled with this re-orientation of Mexican cotton production, the three border regions present some very knotty international problems with regard to water rights, which are pressing for solution.

Mexicali

The Mexicali Region, second in importance in cotton production, occupies part of the delta of the Colorado River in the territory of Baja California. The surface is a gently sloping plain, ranging in elevation from sea level in the western part to over 100 feet in the northeastern part. Above the plain rise a few volcanic hills (Figure 2), such as Cerro Prieto, while to the west the Sierra de los Cucopas mark the sharp boundary of the region. To the east are the Yuma and Santa Clara mesas of Sonora. The slope of the Plain is generally westward from Yuma along the spreading cone of the delta, making this area well suited to irrigation. The soils vary from adobes to very fine sands, but in the northeast there is some windblown sand, still shifting with heavy winds. The more common soils are derived from mixed deposits of silt and sand, hold water well but do not contain excessive alkali. There are seepages in

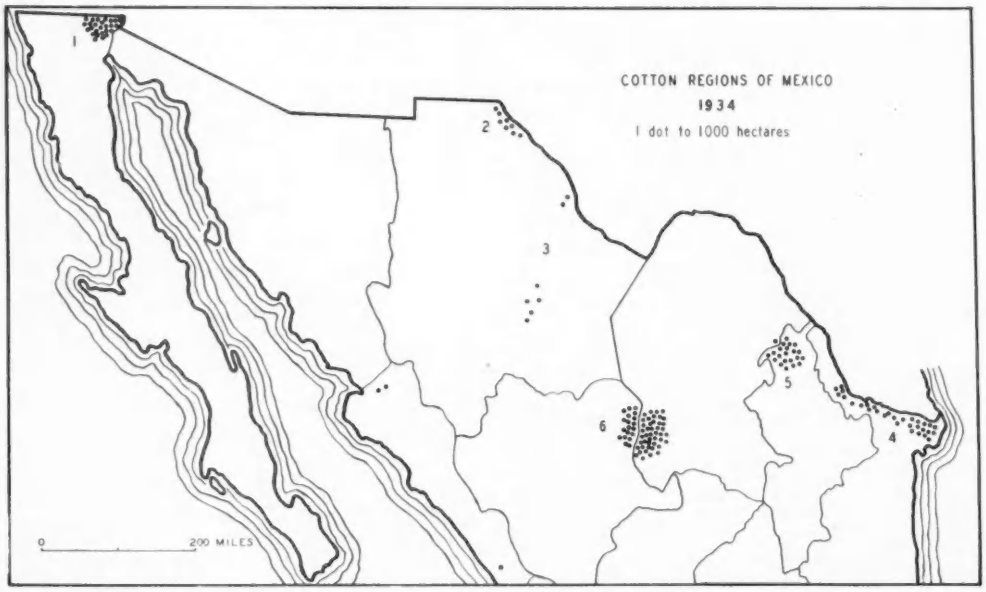

FIGURE 1.—The cotton regions of Mexico, 1934. Each dot represents 1,000 hectares of cultivated land in cotton and the distribution approximately outlines the regions. 1. Mexicali; 2. Juárez; 3. Conchos; 4. Matamoras; 5. Don Martín; 6. Laguna. (Statistical data from Estadística Sobre Algodón. Decenio 1925–1934. Direccion de Economia Rural. Mexico, D. F. 1935.)

the marginal areas, however, in which the soils are strongly alkaline. (Knifen, F. B., The Natural Landscape of the Colorado Delta. Univ. Calif. Pub. in Geog. 5: 210, 1932.)

Irrigation is almost entirely from the Alamo Canal which leaves the Colorado at Laguna, about 15 miles above Yuma. The canal trends southward, enters Mexico a few miles west of Yuma, curves westward along the cone of the delta and, after a portion of the water has been diverted into the Mexican laterals, re-enters the United States to irrigate the Imperial Valley of California. The canal follows this roundabout course (from the standpoint of the United States) because of the higher sand hills along the international boundary. The Alamo Canal carries a large quantity of silt which accumulates in the laterals, necessitating frequent dredging.

The first experiment in the growing of cotton in the valley was in 1901 at El Centro and the following year at Calexico. Experiments were conducted for some years but until the varieties "Triumph" and "Mebane" were introduced from Texas, cultivation did not get under way in the Mexicali area. In 1912 the "Yuma" variety of Egyptian cotton was introduced and proved successful. Cultivation gradually increased to over 80,000 bales (500 lbs.) in 1926–27, after which there was a sharp decline to about 10,000 bales in 1932–33, followed by an increase to 61,000 bales in 1936. ("El Campesino" Revista Agrícola. 1: 20, Mexicali, April, 1937.) Of the 100,000 acres usually harvested, 60,000 are in cotton, 16,000 in wheat, 12,000 in alfalfa for the draft animals, 5,000 in barley largely for beer, and 2,500 in corn, the last not sufficient to supply local needs.

Until recently a large share of the land in the valley was held by the Colorado Land Company, which controlled more than 600,000 acres, only a small part cultivated. Most of the remainder

was held by smaller land companies and very little by small individual farmers. In 1926, when first visited by the writer, the largest holding was administered much like a large plantation. The agricultural workers, Mexican, Chinese, and Japanese, were share croppers or cash renters. Funds for seed, implements, and subsistence were advanced by the company bank and charged against the cotton crop. The company supervised carefully the planting, cultivation, and irrigation. In March and April, 1937, most of the privately controlled land was expropriated by the Mexican Government, placed under the supervision of the *Banco Nacional de Crédito Ejidal* and divided into *ejidos* (communal holdings) of approximately 5,000 acres each, with about 150 families per *ejido*. The administration is not unlike that of the land companies and will be discussed more fully in the section on the Laguna Region, where the plan is more completely developed.

At least 400,000 acres could be cultivated in this district if there were sufficient water and demand for the products. But the region is decidedly handicapped by its position with respect to the main body of the nation. Cotton which is sent to the interior markets of the Republic passes through the United States either via Arizona and the Mexican Southern Pacific Railway, or through California, via San Diego and thence by boat to Veracruz. Wheat and flour are exported from San Diego or the Mexican port of Ensenada. It need scarcely be pointed out that export to the United States is curtailed by the tariff wall. On the other hand it should be pointed out that the district is favorably situated for the export of cotton to Japan.

The most fundamental factor which will influence the future prosperity and growth of the Mexicali area is the distribution of water in connection with the All-American Canal. It has been the policy of the United States to provide the district with enough water to irrigate the land under cultivation, that is, about 750,000 acre-feet annually. This is in keeping with the treaty of 1906, which stated that Mexico should have enough water to take care of existing developments, but it was specifically stated that this could not be construed as a claim. (Timm, Charles A., "Some International Problems Arising from Water Diversion on the United States-Mexican Boundary." *Southwest Soc. Sci. Quar.*, 13:1, 1932.) With the construction of the All-American Canal and new developments on the Rio Grande, the whole problem of the division of water has come up for discussion. The new Canal leaves the Colorado at Imperial Dam about ten miles above the old one, leads through a series of desilting basins and follows along the international boundary line (Figure 3), on the north side to the Imperial Valley of California. A proposed branch will lead northward to the Cochella Valley, making new demands on the water supply. It is evident that the United States can, as it chooses: (1) supply Mexico

FIGURE 2.—A cotton field in the Mexicali area in January, looking south toward Cerro Prieto, a volcanic remnant. The cotton plants are short and the rows closely spaced. Some cotton remains to be picked.

FIGURE 3.—The All-American canal in construction near the international boundary line, about 30 miles east of Mexicali. Cut deeply in windblown sand the canal will carry water to the Imperial Valley of California without passing through Mexican territory.

with silt-free water; (2) supply the water with its burden of silt; (3) dump only the silt-laden flushings back into the Colorado, forcing Mexico to divert and de-silt a very limited quantity of water. The position of the United States in the lower Colorado is strong, that of Mexico weak, but in the lower Rio Grande the positions are somewhat reversed. Mexico insists that any new agreement must involve both rivers. The situation in the lower Rio Grande is discussed in connection with the Matamoras region.

JUÁREZ

This region extends from Ciudad Juárez, opposite El Paso, down the flood plain of the Rio Grande to the vicinity of San Ignacio, a distance of about 30 miles. Cultivation of cotton began in 1922 when 185 bales were produced. The greatest production was in 1926, 14,000 bales, but the average production is about 10,000 bales, produced on 20,000 acres of land. Wheat, alfalfa, and corn are the secondary crops. The quality of the cotton is the best in Mexico, of long fibre, 1 1/16 to 1 1/8, grading 26 per cent good middling and 62 per cent strict middling (with Conchos). The quality is largely due to the comparative scarcity of pests, but the yield is reduced by the high alkalinity of the soils.

If more water were available for irrigation cultivation could be improved and extended. Water is taken from the Rio Grande at a point above Juárez and carried by one large ditch, the *Aséquia Madre*, to the higher parts of the elongated region. There has been a constant demand in recent years for more water but the treaty with the United States provides for only 60,000 acre-feet and the river has several additional demands, including the San Luis Valley in Colorado, the Rio Grande Valley in New Mexico, the El Paso district, the Laredo district, and the Lower Rio Grande Valley. Further extension of any of these irrigation projects will result in a shortage of water, especially in dry years, such as 1935. Mexico has long felt that she has a bargaining point in this district, since a part of her territory, Córdoba Island, lies to the north of the river, thus making it possible to construct a dam and divert more water into Mexico at this point. But another dam in construction above El Paso will make it easy to divert all the water into the United States. For the present the Juárez region will continue to receive the usual 60,000 acre-feet, pending a new agreement on the whole Rio Grande problem.

CONCHOS

The Conchos district, in the state of Chihuahua, extends for 300 miles along the river of the same name, to its confluence with the Rio Grande. It has little of the homogeneity of the other cotton areas; the upper part lies next to the foothills of the Sierra Madre; the middle section is in broad basins; the lower portion is in the flood plain of the river Water for irrigation is supplied by the Rio Conchos and its tributaries. A

large dam in the upper part, La Boquilla, impounds three million cubic meters in a reservoir covering 43,000 acres. There are other auxiliary dams completed or under construction which will aid in irrigating 160,000 acres. Cultivation of cotton has increased rapidly in recent years as more water has been made available; in 1931 only 1,000 acres were planted to cotton, but by 1934 the area had increased to 17,000 acres and the yield to 9,000 bales. In addition wheat, corn, alfalfa, beans, and peanuts are cultivated.

FIGURE 4.—A non-irrigated cotton field near Reynosa in the Matamoras region. In the background is the uncleared mesquite chaparral, the most common vegetation formation.

MATAMORAS

This long narrow region follows the flood plain of the Rio Grande from Mier to Matamoras, a distance of 125 miles, but cultivation is intermittent. The rainfall is sufficient (30 inches at Matamoras) to yield a fair cotton crop and there is very little irrigation although water is available from the Rio Grande by pumping 20 feet or more. Of the 60,000 acres in cultivation in this region about 37,000 are in cotton of which 25,000 are in the vicinity of Matamoras, 22,000 are in corn and the remainder mostly in beans. The crops offer a striking contrast with those on the north side of the river, where citrus and truck crops are of first importance and cotton is relatively a secondary crop. Away from the flood plain on the Mexican side there is some cultivation of cotton on the rolling, gravel-capped mesas (Figure 4) but most of the cultivated land is in corn.

The most striking quality of the region is the lack of irrigation. The explanation lies largely in the limited market and in the expense of installing and maintaining pumps, for the Rio Grande River is intrenched from 20 to 30 feet below the flood plain and water would have to be pumped as much as 60 feet to reach the higher terraces. Since the flood plain slopes away from the river it is possible to irrigate some of the land by gravity but adequate flood control would have to be provided. It is noteworthy in this connection that 70 per cent of the water in the lower Rio Grande comes from the Mexican tributaries and should Mexico take her share of the water, the irrigation projects on the United States side would be seriously handicapped. Under present conditions it does not seem likely that Mexico will claim her share but she is nevertheless using her strong bargaining position in the lower Rio Grande, in the settlement of the Colorado situation. Furthermore, the tributaries are being developed, thus reducing the flow in the

FIGURE 5.—Hoeing young cotton at Laguna in April. Broad, nearly flat fields are bordered by rows of cottonwoods along the ditches.

lower Rio Grande. Dams have been completed in the Conchos and Salado rivers, providing water for 280,000 acres and a dam is under construction on the San Juan River providing for 140,000 acres, largely in the Rio Grande Valley.

DON MARTIN

This cotton region in northwestern Nuevo Leon takes its name from the dam which impounds the waters of the Rio Salado and lifts them high enough to irrigate the gravelly mesas on both sides of the river for a distance of 50 miles below the dam site. The region was formerly cultivated very little because of light rains (6-12 inches) and the lack of facilities for irrigation. It lies in the piedmont of northeastern Mexico and the immediate vicinity may be described as a series of mesa-like ridges extending southeastward from the mountains and separated from each other by the Rio Salado and its tributaries, which are entrenched in barrancas 30 to 60 feet deep. The farming land is therefore not subject to floods, but only a high dam enables the water to reach the tops of the mesas. Even so, a portion of the mesas are too high and too rough for cultivation. The water is furnished by the rivers Sabinas and Nadadores which unite to form the Rio Salado in the present limits of the reservoir. The natural vegetation of this district is chaparral or monte, with mesquite the most common plant, but with a great variety of woody shrubs. Before the construction of the dam the country was good only for grazing cattle, goats, and mules. The system of irrigation first began to operate on a large scale in 1933, a number of new colonists were brought into the area, a large portion of them repatriated workers from the United States. Cotton immediately became the principal crop followed by corn, wheat and beans, and alfalfa. In 1933, 90,000 acres were under irrigation by 1,500 colonists. By 1936 Don Martín was producing more than 8 per cent of Mexico's cotton crop. (Boletín Mensual de Estadística Agrícola. Direccion de Economia Rural. 126: 1522. Mexico, D. F. November, 1936.) But when the reservoir was visited in the winter of 1937–38 it was almost completely dry. Deficient rains and excessive seepage were largely responsible. A menace that is perhaps even more serious is the appearance of alkali in many localities after three or four years of cultivation. Both the soils and the water are high in soluble mineral and only the most skillful handling will assure the continuance of cultivation.

LAGUNA

Comarca Lagunera, usually known simply as "Laguna," lies on the border of Coahuila and Durango and is the oldest and most important of the cotton regions. A large irregular basin consisting in part of the beds of playa lakes is surrounded by arid basin ranges. The ranges furnish no water for irrigation and only the floods of the Nazas and Aguanaval rivers, irregular and undependable in regime, supply water in large

quantities. The headwaters of these rivers are in the Sierra Madre Occidental where summer rains are heavy but irregular. The water does not usually reach Laguna until September or October and this "flood" irrigation must suffice for the cotton which is planted the following February, since at other times the streams are dry. A small amount of water is supplied by wells, which are being drilled in increasing numbers, but the region is seriously handicapped by the irregularity and uncertainty of the water supply. A dam is under construction in the Rio Nazas, 150 miles above Laguna, which will regulate the flow and provide more water for irrigation at a more suitable season.

Originally the Laguna area was a grant from Charles II of Spain, embracing more than a million acres of ranching land. There was little subdivision until 1850, when by succession and sale the number of property holdings increased. Cotton cultivation began at this time and contributed further to the division of property but as late as 1930 there were only 322 rural properties, of which 131 were *haciendas,* 93 *ranchos,* 10 *ejidos,* 77 parcels, and 21 subdivisions. At that time the rural population included 33,000 workers and their families. Forty per cent of the land was worked directly by the proprietors, 30 per cent by partnerships, 21 per cent by renters and 7 per cent by sub-partnerships. (Informe de la Agencia del Banco Nacional de Crédito Ejidal, Torreon, Coah. August, 1937. Mimeographed.) Following expropriation (October 1936) Laguna was divided into 277 *ejidos,* which included 346,000 hectares and a working population of more than 30,000. In 1937 the Federal Government spent more than $40,000,000 (in pesos) in wages, machinery, wells, etc., in the expectation of a bumper crop and a large money return. But owing to the delay in establishing the new system, planting was delayed,

FIGURE 6.—Wheat fields at Laguna, showing the "squares of irrigation" (emphasized by dotted lines). In the latter part of April the wheat is nearly ready for harvest. In the distance is one of the basin ranges which surround Laguna.

FIGURE 7.—The village nucleus of an *ejido* in Laguna. Most of the houses, including the school, are of adobe. Corrals and some dwellings are of local bamboo. All the villages are very compact and there are few isolated houses.

pests made heavy inroads, and the crop was about one-half of normal.

On the surface the expropriation has made little change. The first impression of Laguna is of clean fields, well cultivated, bordered by groves of cottonwoods and salt cedars (Figure 5). There are numerous large irrigation ditches, waterless except in late summer and "irrigation squares," which retain the floodwaters on the fields, bordered by ridges of earth (Figure 6). Where there are wells there is also a system of small ditches and fields of alfalfa which cannot be grown by flood irrigation alone. Cotton is dominant but wheat is increasing in acreage.

The *ejidos* still resemble the *haciendas* and *ranchos* from which they were formed. Usually the old village nucleus is used as headquarters for the *ejido* (Figure 7). A fairly representative *ejido* is Las Conchas, three miles northeast of Torreon. The unit covers 1,400 hectares of which 450 were in cultivation in April 1938. The cultivated land is equally divided between wheat and cotton, the former nearly ready for harvest, the latter only a few inches high. The acreage of wheat has been increased but part of the crop was a failure, due probably to the use of seed ill-adapted to the region. There was no water available on this *ejido* but a well was being dug; one well with a six-inch pump will irrigate 40–50 hectares. The *ejidos* which have wells usually grow corn and alfalfa in addition to wheat. The pop-

FIGURE 8.—Airplane view of part of Torreón, the commercial center of Laguna. Torreón has grown up in the last 75 years and is important for smelting as well as cotton. It is more like a city in western United States than most Mexican cities.

ulation of Las Conchas is 146, all of which must be supported from the sale of cotton and wheat, since no corn is produced.

Laguna is the biggest "new deal" experiment of the Mexican Government, involving not only a new type of land ownership but new methods of cultivation as well. The plan involves a new system of irrigation, with dams, larger ditches, and wells, a new system of crops with more wheat, more alfalfa and livestock, more income and better living conditions for the farmers. The small crop for the first year raised cries of "failure" from many Mexicans, but there is no evidence of it on the ground. The government may lose money for several years, but unless production continues at the low level of 1937, the new system cannot be counted a failure from the standpoint of the workers.

CONCLUSION

During the last decade cotton production in Mexico has fluctuated but there has been no decided trend. An average of about 400,000 acres has produced a little over 200,000 bales. But, from the standpoint of productive activity, there should be an increase in the next few years; obviously the government is aiming to increase the country's most valuable commercial crop. Three regions, Laguna, Matamoras, and Conchos, should increase production on the basis of new irrigation systems alone. The other regions are not so likely to increase because of the limited supply of water; of these Don Martín is the most doubtful since it faces a serious alkali problem as well.

More than three-fourths of the total crop is consumed in Mexico. Cotton lint moves from the production centers to the textile mills in a pattern which depends not only on the relative location but on the special quality of the fiber as well. A large proportion of the Laguna production goes to Puebla, the Federal District, and Veracruz; only a small portion is consumed in Torreon. The Mexicali cotton is sent by boat to Veracruz and by rail to Guadalajara. From Juárez and Conchos the cotton goes to Veracruz, Puebla, and the Federal District. Matamoras ships to Monterrey, Puebla, and Veracruz, while Don Martín supplies Monterrey, Tlaxcala, Toluca, and Saltillo. Most of the export cotton goes to the United States (which imports a limited quantity of long fiber), Germany, Japan, and France. Cotton is by no means the most important export crop; it is surpassed by henequen, coffee, and bananas. But it bids fair to continue as the most important commercial crop.

All statistical data, unless otherwise noted, are from Estadística Sobre Algodón. Decenio 1925–1934. Direccion de Economia Rural. Mexico, D. F. 1935.

NORWAY'S INDUSTRIALIZATION

Claudia Thomson

NORWAY, through the development of geographic features usually considered adverse, has become an industrialized nation. Located on the Arctic Circle, geographic features are ice fields covering 4 per cent of the surface of the country; many rivers of ice creeping slowly down mountain sides; snow-covered winters, and summers of abundant rainfall, with precipitation of more than 70 inches a year in some localities along the west coast. The ice, snow, and rainfall, coupled with precipitous mountains of rock, ranging from 1,500 to 6,000 feet in height, cause numerous waterfalls with a dependable flow of water. These waterfalls, as well as a number of short, swift streams, have caused Norway's industrial development to be based on hydroelectric power.

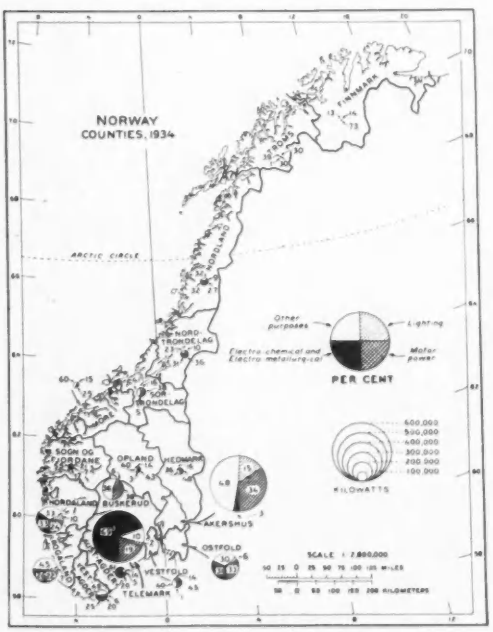

FIGURE 1.—Distribution of developed hydroelectric power by counties as of 1936 (Statistisk Arbok). The Norsk Hydro is located in Telemark County. Oslo, the largest city in Norway, located in Akershus, and Bergen, the second largest city, located in Hordaland, account for the large power developments in those counties.

Waterfalls, the country's greatest natural resource, have been furnishing power through the centuries, but have been developed since the beginning of the twentieth century only. The progress which an enterprising people has made toward industrialization, based almost entirely on geographic and economic disadvantages, is indicated in this discussion. Statistics showing the distribution and trend of the electrical industry are presented; future possibilities are mentioned. It is hoped that the general reader will find this article informative and that it may contain material of interest to those in the electrical field and allied industries. If the reasons for, and the scope of, the development of the electrical industry in Norway have been presented, the purpose will have been fulfilled.

GROWTH OF HYDROELECTRIC POWER

Norway's numerous waterfalls have been turning primitive water-driven flour mills and saw mills since the sixteenth century. However, the use of waterpower for generating electricity is of recent date. A pulp-grinding mill near Skien in southern Norway began to operate the first works for the supply of electricity for domestic purposes in 1885. In 1891, works were put up in Hammerfest in the extreme northern part of Norway. In 1892, Oslo, the capital city in Akerhus County, generated its first electricity which was based on steam.

In 1910 only 14 per cent of the buildings in Oslo had electric current installed; 90 per cent in 1920; and 100

per cent by 1925. Electrical current for automatic signals also had a rapid growth as the 3,111 installations in 1910 had increased to 19,623 by 1928.

After 1900, many towns began to erect power plants, and by 1910 nearly all towns had their own supply of electricity. Today approximately 75 per cent of the population has access to, and is financially able to use, electrical current. About two-thirds of the farms of the country use power not only for lighting and heating but many also use electricity for other purposes, such as running engines for various uses and for turning cream separators.

In 1894, the developed hydroelectric power in the country was less than one-tenth of 1,000,000 kilowatts. For the next twenty years the growth was gradual, reaching 482,338 kilowatts in 1914. After 1914 hydroelectric power development increased rapidly and reached 2,947,296 kilowatts in 1936. Today Norway has the largest per capita hydroelectric power, both developed and potential, of any country in the world.

TABLE I

County	Hydroelectric Resources		
	Installations[1]	Developed[2]	Potential
	Kilowatts	Per Cent	Per Cent
Finnmark	15,534	1.0	99.0
Troms	9,948	2.4	97.6
Nordland	73,563	6.3	93.7
Nord-Trøndelag	69,090	11.2	88.8
Sør-Trøndelag	78,905	10.7	89.3
Møre	42,978	3.5	96.5
Hedmark	57,087	5.4	94.6
Opland	50,285	4.8	95.2
Sogn of Fjordane	57,623	3.3	96.7
Hordaland	218,791	10.1	89.8
Buskerud	116,913	21.4	78.6
Akerhus	444,790	68.1	31.9
Rogaland	213,710	10.0	90.0
Vest-Agder	70,563	7.2	92.8
Aust-Agder	98,741	16.1	83.9
Telemark	490,721	38.4	61.6
Vestfold	73,851	10.9	89.1
Østfold	235,850	64.8	35.2

Compiled:
[1] Statistisk Arbok, 1933.
[2] *Norges Industri*, Organ of the Federation of Norwegian Industries, special number, 1932.

Table I gives the estimated percentage of available hydroelectric power which has been developed in each county. The assumption is made that these percentages represent installations reported for each county for 1932.

For the country as a whole, approximately 14 per cent of all the available waterpower has been developed. The waterfalls of the country are well distributed over the entire surface and are especially numerous in the southern part of the country and along the west coast where geographic conditions are most favorable to development of hydroelectric power. The fjords, navigable far inland and ice-free, give favorable transportation facilities for power plant equipment at the time of construction and later for the transportation of manufactured products. The more northern counties, though not so rugged and mountainous as the southern part of the

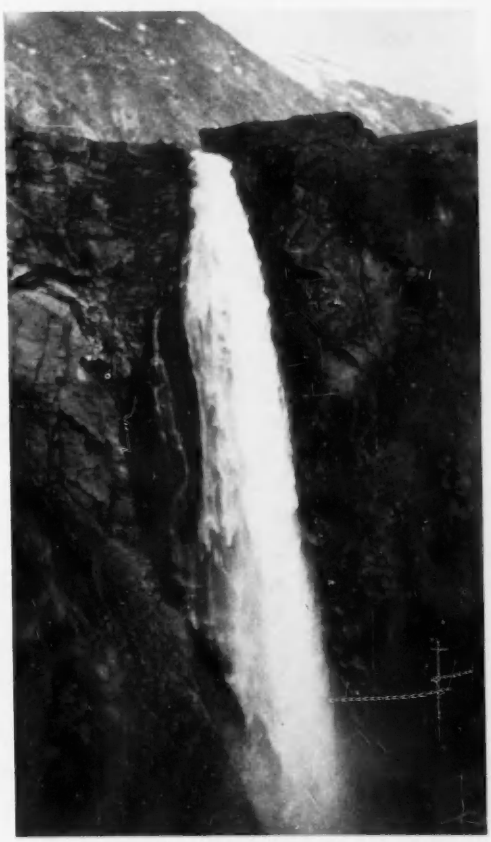

FIGURE 2.—Waterfalls near Alesund in More County. Note precipitous mountain of solid rock and the snow-covered peak in the distance.

country, have large undeveloped hydroelectric resources. The heavy downpour of rains and the heavy snows of winter cause a most dependable flow over the high falls which can be so regulated as to give constant power throughout the year.

Power development has been very largely along three distinct, yet connected, lines; (1) power plants which sell energy; (2) industries in which electrical energy is the most important agent; and (3) industries which supply the electro-technical equipment necessary in the first two mentioned.

Costs of Developing Hydroelectric Power

Accurate data on costs of developing electrical power in Norway do not appear to be available. However, in 1929 it was estimated that a sum approximating $300,000,000 had been invested in the development of electrical power. It was also estimated that if installations to utilize power were included, the sum invested would probably be about $375,000,000.

Future developments will probably be more costly than those up to the present, since it is natural that the waterfalls most favorably located should be developed first, and that those less accessible should require greater capital. In industry, it is said that cost of power transmission disappears almost entirely while for domestic use the transmission cost is low.

Electricity is sold in Norway on a tariff or schedule basis. A consumer subscribes for an estimated yearly maximum consumption for which a specified annual price is paid. The maximum subscribed for is indicated on a current-limiter which automatically limits the use to that maximum. Prices vary from about 3 øre to 8 øre (or in American money from about ¾ cents to 2 cents) per kilowatt hour, depending upon the efficient use of current. Estimated per capita consumption of about 2,800 kilowatt hours for domestic uses

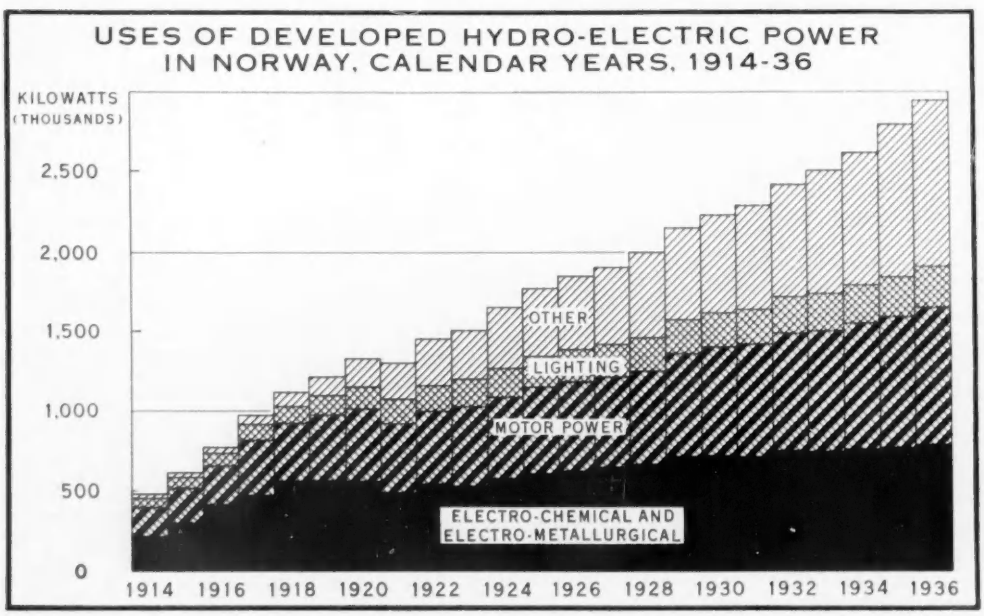

FIGURE 3.—Principal uses of hydroelectric power in Norway. Installations have increased from about 500,000 kilowatts in 1914 to almost 3,000,000 kilowatts in 1936. That use indicated as "Other" shows an extraordinary increase due primarily to use for domestic purposes.

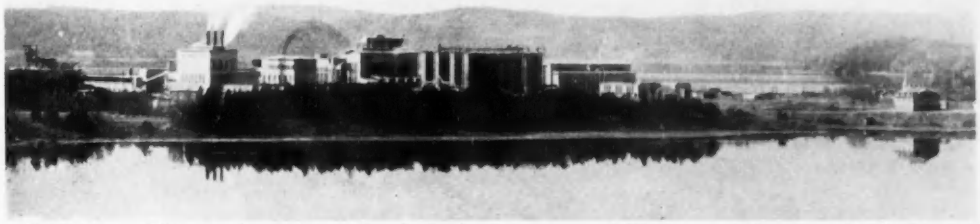

FIGURE 4.—Nitrate plant of the Norsk Hydro Company at Eidanger. (Courtesy U. S. Department of Commerce.)

in 1929 compares with about 100 kilowatt hours for similar uses in Europe as a whole. Assuming that per capita consumption for domestic uses since 1929 has increased in proportion to electrical installations, the per capita consumption in 1936 would probably be more than 3,800 kilowatt hours. Electricity in the home has relieved the modern Norwegian woman of much drudgery and has given her time for numerous activities—economic, social, and political—outside the home. Much of her advancement in the past three decades can be attributed to time-conserving electrical appliances. A very large portion of use labeled *other* (Figure 3) is for household purposes and indicates the extensive electrification of the home.

About 60 per cent of all power stations is owned by municipalities, while about 30 per cent is privately owned, and the remaining 10 per cent is owned by the State.

INDUSTRIES

Norway has become industrialized during the past 25 years, and approximately 28 per cent of the population is employed in industry. Previously, because of the limited raw materials and no coal or oil, the country depended to a great extent upon its small agricultural possibilities and its great fishing and shipping possibilities. "While the sea drew, the land drove in the same direction." (Semple, Ellen Churchill, *Influences of Geographic Environment,* New York, 1911, p. 15.) The harnessing of the country's greatest natural resource, waterfalls, has been done largely with imported capital and always with the thought foremost of preserving this greatest natural resource for the people and the country. The attempt has been to prevent speculation and check any foreign control which might become potent. (For concessions and regulatory measures in some detail see *The Norway Year Book* (English), Oslo, 1931, pp. 289–93; and *Olafsen,* Birger, "Brief Survey of Legislation relating to Water Courses and Electricity," in *The Norwegian Trade Review,* Vol. XII, pp. 27–8.)

Norway possesses rich raw materials in fisheries and forests and these two products form a large part of the industries of the country outside of the electrochemical and electrometallurgical products which will be discussed later in this article. Fish-canning factories exist in every part of the country. Paper, pulp, and cellulose form one of the most important industrial groups. These two industrial groups have grown and have added much to the exports of the country since such large-scale electrification has taken place.

Besides canning and the wood pulp industries, other industries are the manufacture of fishing tackle, lines, ropes, nets, fish hooks, and oil clothing; hides and skins which give rise to tanning in-

dustries; condensed milk, powdered milk, and cheese; rubber goods such as shoes and belting; wood products, lumber, box boards, planks, telephone poles, pit props, veneers, barrels, and skis; wet pulp for paper manufacture, paper, and paper products, and cellulose for artificial silk. Iron and metal works manufacture stoves, ship parts, sawmill equipment, turbine equipment, agricultural machinery, motors, and machinery for cod-liver oil and fertilizer factories. Iron and steel ships up to 10,000 tons are built in Norway's own ship yards. Floating factories for oil and fertilizer are also built. The country has textile industries in wool, silk, cotton, and linen, but much of the textile manufacture is kept in the homes to provide a cash income and year-round employment in city and on farms.

Table II shows percentage changes in use of total power since 1914.

ELECTROCHEMICAL AND ELECTROMETALLURGICAL INDUSTRIES

The foundation of Norway's industrial development has been the electrochemical and the electrometallurgical industries. These industries are those requiring a great amount of electrical current and a minimum amount of raw materials, most of which are imported.

Before 1900 the only electrochemical product exported was calcium carbide, which was the first electrochemical developed. However, the best known chemical product of Norway is calcium nitrate (Norgessaltpeter) which is used both in industry and as a farm fertilizer. Norwegian calcium nitrate is pure, while Chilean nitrate, of which Norway formerly imported large quantities, contains other elements, such as iodine, boron, magnesium, potassium, and calcium which owe their presence to the fact that Chilean nitrate is a natural product.

The largest and by far the most important plant is the Norsk Hydro Elektrisk Kvaelstoff A/S, which is commonly known as the Norsk Hydro (Figure 4). The foundation for the electrochemical industry and the Norsk Hydro was laid by Professor Kristian Birkeland and Engineer Samuel Eyde in 1905. In that year a small plant was built at Notodden to be run on a commercial scale. This small plant grew into the Norsk Hydro which in 1916

TABLE II

	Total Installation Kilowatts	*Per Cent of Total Devoted to—*			
		Lighting Per Cent	*Motor Power Per Cent*	*Electrochemical and Electrometallurgical Per Cent*	*Other Per Cent*
1914	482,338	13	37	47	3
1915	619,627	11	35	49	5
1916	774,992	10	31	55	4
1917	976,230	11	35	49	5
1918	1,127,116	10	32	50	8
1919	1,221,915	10	34	47	9
1920	1,335,491	11	34	42	13
1921	1,303,980	12	33	38	17
1922	1,456,640	11	31	38	20
1923	1,513,006	12	33	35	20
1924	1,654,740	11	31	35	23
1925	1,775,723	11	30	35	24
1926	1,852,668	11	30	34	25
1927	1,908,497	10	30	34	26
1928	2,000,139	10	29	34	27
1929	2,153,422	10	30	33	27
1930	2,233,926	10	30	32	28
1931	2,288,512	10	31	31	28
1932	2,418,943	10	30	31	29
1933	2,504,402	10	30	30	30
1934	2,612,647	10	30	29	31
1935	2,793,953	9	29	28	34
1936	2,947,296	9	29	27	35

Compiled from Statistisk Arbok.

built its principal plant in southern Norway at Rjukan in Telemark County where Norway's greatest waterfalls are located. Twenty-five years ago Rjukan and the surrounding area was a mountain valley with many peaceful, small farms. Today it supports a thriving city of more than 10,000 inhabitants and has the most modern industrial development in the world. Norway has several electrochemical plants, but none of such large proportions as the Norsk Hydro (Figure 1).

A word as to the process used in the production of calcium nitrate might be of interest: "By means of 45,500 hp. water-driven turbines coupled direct to electrogenerators, an electric disk-flame of 7 feet in diameter is produced in fire-brick furnaces. Combustion of the nitrogen in air blown through these furnaces results in the formation of nitric oxide. By means of granite water-absorption towers this nitric oxide is absorbed and a weak nitric acid (30 per cent) produced, which is passed over limestone to form a solution of nitrate of lime. After concentration the liquid nitrate is solidified by cooling and reduced to the well-known granular form of nitrate of lime." (The Norway Year Book (English), Oslo, 1931, p. 347.)

The electrometallurgical products are based almost entirely on imported raw materials. Aluminum is probably the best known of this group, and for this product there is practically no domestic market. However, abundant and cheap electrical power is one factor favorable to its manufacture, and Norway produces roughly one-seventh of the world's aluminum.

The production of cement in Norway has also shown great progress since the turn of the century. Norway has produced cement since 1892, but on a commercial scale in the more recent years only. Norwegian limestone is exceedingly hard, and only since the development of hydroelectric power has it been possible to break up this limestone with any degree of ease. Great amounts of Norwegian cement have been used in the building industry during more recent years, and cement has been an important export since 1921.

FIGURE 5.—Power plant near Trondheim on Norway's west coast three degrees south of the Arctic Circle, in Sor-Trondelag County.

ADVERSITIES AND RECOVERY

During the World War period, Norway expanded its electrochemical and electrometallurgical production at high cost levels to meet increasing export demands. With the sudden cessation of hostilities, the country was left with these industries operating far below ca-

TABLE III

EXPORTS OF ELECTROCHEMICAL AND ELECTROMETALLURGICAL PRODUCTS FROM NORWAY, 1912–36

(Metric ton = 2204.6 pounds)

	1912 *Metric Tons*	*1913* *Metric Tons*	*1914* *Metric Tons*	*1915* *Metric Tons*	*1916* *Metric Tons*	*1917* *Metric Tons*	*1918* *Metric Tons*
Calcium nitrate	51,701	70,927	75,176	38,609	46,001	35,932	53,625
Calcium carbide	63,095	66,911	63,723	79,481	58,433	46,067	41,772
Cyanamid	13,892	22,111	13,720	24,609	13,152	2,313	10
Ammonium nitrate	4,270	9,107	11,959	26,459	59,639	63,578	49,588
Natrium nitrat	.....	811	9,306	7,475	14,783	22,711	2,637
Superphosphate	.....	.....	.....	.....	.....	.....	.....
Zinc	8,914	10,538	16,517	22,617	28,150	18,395	3,390
Nickel	385	594	696	761	723	442	60
Aluminum	1,140	2,177	2,942	2,883	4,488	7,601	6,835
Tin	2	....	11	16	1	1	[1]
Ferro-silicon	6,022	6,324	6,144	9,308	25,256	29,450	16,861
Ferro-chrome	676	1,642	2,796	3,300	2,875	3,550	3,794
Ferro-manganese	....	....	....	....	....	....	....
Silico-manganese	....	....	....	....	....	....	....
Cement [2]	6,488	6,254	2,748	4,879	2,282	19	919
Total	156,585	197,396	205,738	220,397	255,783	230,059	179,491

	1925 *Metric Tons*	*1926* *Metric Tons*	*1927* *Metric Tons*	*1928* *Metric Tons*	*1929* *Metric Tons*	*1930* *Metric Tons*
Calcium nitrate	156,965	174,303	136,546	111,730	207,548	366,639
Calcium carbide	29,478	26,020	30,533	25,271	31,907	23,460
Cyanamid	6,495	10,516	32,230	54,246	65,558	48,509
Ammonium nitrate	.....	3,342	7,765	6,363	5,573	4,622
Natrium nitrat	31,118	28,231	33,905	34,568	28,269	28,055
Superphosphate	80	132	202	498	514	363
Zinc	2,344	5,219	5,695	2,119	3,062	27,097
Nickel	.....	[3]	25	463	396	708
Aluminum	20,548	22,132	22,076	16,843	29,584	23,676
Tin	64	87	90	99	119	126
Ferro-silicon	23,036	17,665	29,445	29,772	40,896	27,699
Ferro-chrome	2,517	2,198	4,010	2,801	3,870	4,141
Ferro-manganese	49,015	79,235	70,993	77,310	68,981	47,848
Silico-manganese	.....	.....	.....	.....	6,991	4,356
Cement [2]	174,018	29,055	148,857	160,353	164,274	137,118
Total	495,678	398,135	522,372	522,436	657,542	744,417

Compiled from *Norges Handel:*

[1] Sixty kilograms, only.

[2] While cement is not strictly an electrochemical or electrometallurgical product, its manufacture in Norway is largely

[3] Sixty-seven kilograms, only.

pacity, and returns were not in proportion to investments. The export trade was adversely affected until about 1923 (Table III). The revival of industry after 1923 improved economic conditions generally. In some instances, communes helped to defray the high costs at which industry had been built, and in the case of municipal electrical works, the state granted sums to cover loss of interest on state loans. State loans were also granted with partial exemption of interest.

Again after 1929 during the world-wide depression, sales of chemicals were reduced, and labor troubles caused production to cease, in some cases and some types of industry for as much as six months.

However, a summary of economic Norway for 1937 indicates a substantial upward trend in industrial production and economic welfare generally. Industrial production was reported as the largest on record. Electrochemical production was about what it was in 1936 and exports increased considerably. Production of electrometallurgical products was greater than in the years just preceding, and prices were higher.

FUTURE ELECTRICAL DEVELOPMENT

There appear to be three factors upon which hinge further development of

1919 *Metric Tons*	*1920* *Metric Tons*	*1921* *Metric Tons*	*1922* *Metric Tons*	*1923* *Metric Tons*	*1924* *Metric Tons*
63,080	117,419	81,876	157,563	147,233	131,298
25,599	31,367	15,676	21,004	28,946	33,492
9,930	15,915	5,339	3,899	.....	.....
5,143	20,335	13,104	1,792	11	13
13,038	18,641	17,313	32,401	22,296	19,488
39	44,648	8,826	3,263	48	53
3,950	11,187	17,207	9,353	1,844	2,828
.....	53	279	147	62	.....
3,120	5,617	6,267	6,177	12,778	19,337
....	14	9	4	34	54
2,422	11,916	5,824	9,847	16,642	19,684
296	1,684	528	1,326	2,691	1,789
....	....	....	....	....	39,525
....	....	....	....	....	.....
6,303	8,389	47,962	90,001	109,652	199,219
132,920	287,185	220,216	336,777	342,237	466,780

1931 *Metric Tons*	*1932* *Metric Tons*	*1933* *Metric Tons*	*1934* *Metric Tons*	*1935* *Metric Tons*	*1936* *Metric Tons*
291,702	312,016	397,856	388,644	353,641	427,555
23,893	22,667	24,310	29,275	33,439	33,291
14,494	24,183	17,240	23,460	34,479	29,772
2,330	1,926	2,749	2,592	1,665	2,419
18,658	63,561	59,236	48,648	28,137	19,712
.....	108	705	558	248	...
45,398	37,811	45,711	42,283	42,147	43,222
2,286	4,088	3,428	5,635	5,774	6,042
24,350	13,595	15,178	14,078	14,622	15,086
94	114	99	99	147	.....
27,061	11,282	22,923	21,512	26,035	29,045
4,856	4,249	8,000	11,887	11,859	11,036
32,029	35,494	37,663	37,273	48,418	59,337
2,270	.....	12,084	11,941	9,865	.....
83,503	61,851	60,876	66,307	46,788	42,677
572,924	592,945	708,058	704,192	657,264	719,194

the result of the highly developed electrical industry.

electrical power in Norway. In the first place, it is not likely that development of water power will be carried on to any great extent with Norwegian capital. To what extent capital can or will be imported depends upon the sound judgment of the Norwegian people and upon the international money market. Secondly, it would seem that manufactories which require immense amounts of electrical energy and a small amount of labor would find remaining possibilities most profitable. The third factor, exporting power, is unique. This possibility has been considered by Norwegian electrical engineers for some time, and each technical improvement makes this possibility seem more plausible. Both Denmark and Germany are in need of power for industrial development, and it has been proposed to build a line south through Sweden into Denmark, making use of the islands between Denmark and Sweden, and thence into Germany. The proposal has been made to build a line which would transmit 500,000 kilowatts. However, a tremendous sum of money, variously estimated, would be needed to build this high-tension line which would require 80 miles of submarine cable or three miles of aerial crossing on 650-foot steel towers. One point in favor of exporting energy would be that the supply would never be exhausted. Two points against it are that it is quite questionable whether or not

FIGURE 6.—Another Norwegian waterfall of power and beauty tumbling over another mountain of rock.

the returns would justify the investment and that such an undertaking would not provide sufficient employment for Norway's growing population.

In conclusion it might be said that the industrialization of Norway is unique in that the industrialization of no other country has been based almost entirely upon hydroelectric power. It is not an exaggeration to say that Norway's industrialization, through hydroelectric power, is based upon the 60 per cent of Norway's surface classified as bare, rocky, and precipitous mountains, and on the 4 per cent of the surface covered the year round by ice fields.

SWINE INDUSTRY OF CHINA

Earl B. Shaw

CHINA, the country with the world's largest human population, has also the world's largest swine population according to the estimates of the U. S. Department of Agriculture as well as those prepared by the Chinese National Agricultural Research Bureau. The number of hogs approaches sixty-three million, or approximately one-fourth of the world total, 23.3 per cent (Figure 1).

In contrast to swine culture in the United States where the number of hogs is second to China and where no swine were raised until European exploration and settlement, Chinese hog husbandry is a very old industry, the hog having been domesticated there as early as 3000 to 2000 B.C. In the Shang Period (1776–1122 B.C.), to judge by the Oracle Bones recently excavated, the horse, ox, sheep, dog, and pig appear to have been the only domesticated animals. That the pig was domesticated as well as hunted in its wild state at that time is indicated by the pictographs of hogs with and without arrows transfixing them. Moreover, the ideographic character of the Chinese home shows a pig under the roof (Sowerby, Arthur, "Domestic Animals of Ancient China," *China Journal*, October 1933).

The production of Chinese swine differs strikingly from that of both the United States and Denmark. In the latter country pigs are produced by what has been described as dairy-by-product feeding, while the corn feeding of the former country is well known. China, however, has a unique way of raising swine, a way which the writer has chosen to call the scavenger method. Pigs are fed on refuse from the table, and refuse from cultivated fields, on food that would go to waste were it not utilized by the most efficient food producer of any domestic animal.

The manure made available by swine production is probably of more importance to the Chinese farmer than to the agriculturist of any other major swine-producing country in the world. Fertilizers are sorely needed to keep productive the intensively cultivated fields that provide food for China's densely populated nation. Indeed, in the mind of the average Chinese farmer the hog is probably considered a machine or converter into which he puts so much waste or raw material, receiving in turn manure which is indispensable to the realization of his crops.

Though hogs may have extreme significance to the Chinese peasant as a source of manure, as many authorities state, the fact remains that swine probably furnish the most important meat item on the farmer's menu. Religion and custom influence the condition more than they do in most pork-producing countries. According to Mr. Lee, Chinese graduate student from the University of Wisconsin, Buddhist tradition fosters belief that the displeasure of heaven is visited upon people who kill cattle for food. Pork, mutton, and chicken offer no such handicap, but mutton finds little favor among the peasants, and thus pork and chicken constitute the important meat element in the diet. While chicken and other fowl are widely consumed, they are probably more expensive than pork as a regular ration, and consequently when meat is eaten, cheaper pork and lard are the meats most likely to be chosen. Moreover, hogs

provide an excellent food item to the hard-working Chinese who need fats to supply energy for the long day's toil. And in a country where fats are none too plentiful, the hog provides them more cheaply than they could be obtained from any other animal.

Among the Mohammedan Chinese, pork is taboo, and their religion limits swine production just as it favors it among the non-Mohammedans.

With these facts in mind it seems that a closer study of swine-raising practices among "the farmers of forty centuries" should be of interest to students of economic geography. To examine these practices by research through the extremely limited relevant material available, and to point out geographic adjustments between swine culture and the Chinese environment, forms the purpose of this paper.

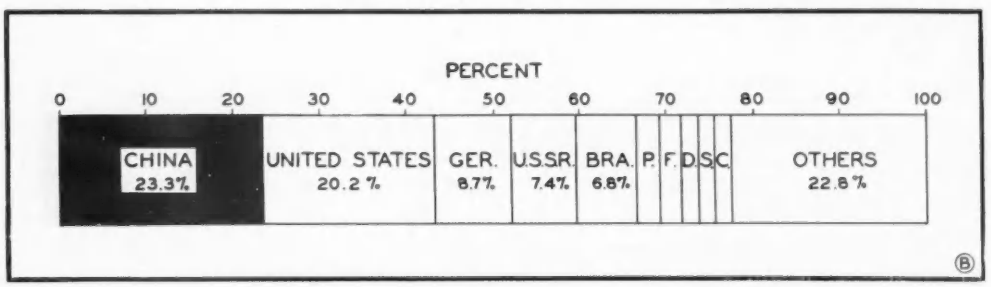

FIGURE 1.—World swine production in percentages. It was impossible to include in every case full names and percentages on the graph. Bra. refers to Brazil; P to Poland with 2.7 per cent; F to France with 2.4 per cent; D to Denmark with 2.0 per cent; S to Spain with 1.9 per cent; and C to Canada with 1.8 per cent. The graph is based upon 1931 figures furnished by the United States Department of Agriculture.

PHYSICAL ENVIRONMENT AND SWINE CULTURE

In discussing the problem of swine distribution in China it is well to bear in mind just what China or what part of China is to be studied. Some people think of China as a land which extends from 18 to 53 degrees north and from 74 to 134 degrees east, a region covering some four and a quarter million square miles and which includes Manchukuo, Mongolia, Sinkiang or Chinese Turkestan, and Tibet. This enormous area has been termed the Chinese Empire or Greater China. As is well known, the Chinese government has little control over Mongolia, Tibet, or Chinese Turkestan and certainly none over Manchukuo. At the time this article is being written uncertainty prevails as to how much of what has been termed China Proper will remain when other nations complete the process of subtraction. China Proper (Figure 2), the area included between parallels approximating 45 north and 21 north and meridians 100 east and 122 east is the region that will be considered in this study, the numbers of swine for twenty-three provinces being represented on the dot map (Figure 3). These provinces include Anhwei, Chahar, Chekiang, Fukien, Honan, Hopeh, Hunan, Hupeh, Jehol, Kansu, Kiangsi, Kiangsu, Kwangsi, Kwangtung, Kweichow, Ningsia, Sikang, Shansi, Shantung, Shensi, Suiyuan, Szechwan, and Yunnan, and aggregate an area of approximately a million and a half square miles with a population estimated to be between three hundred and fifty and four hundred and fifty million people.

Stamp, in his authoritative book on Asia, states that the area of China Proper is slightly less than the whole of

the Indian Empire, and that he considers a conservative estimate of China's population would make it about equal to the number for the great empire to the south. These facts are significant when another is added, namely that the area of mountainous topography (Figure 4) in China is greater than that in India, thus making the density of population in the plains sections, where most of the population is concentrated, even greater than that of India. In the most densely populated agricultural regions, the number of people per square mile probably is greater than that of any agricultural section of the world, some districts containing as high as three thousand to four thousand people to the square mile.

It is in the arable regions, where the densest human population is concentrated, that the dense swine population is found. Notice on the maps the areas of densest human population (Figure 5) and those where the density of swine is the greatest. Then turn to a physical map and note that both these dense populations are found, primarily, in the alluvial lands of the Hwang Ho, the Yangtze Kiang, and the Si Kiang valleys and along the coastal plains. Swine distribution seems to correlate with man's distribution. Densest human population is found on the most productive lands. Where population pressure is heaviest, farms are small and most intensively cultivated, and where intensive cultivation prevails there is greatest danger of soil depletion. The Chinese farmer is too poor to buy commercial fertilizers, if they were available, which would be extremely high in places where transportation is primitive and inadequate. Thus what is more natural than to keep a few swine to eat up the rice hulls, the soy bean refuse, and wastes from the household and at the same time provide manure to build up the soil and furnish meat for food? The sequence of productive plains, dense population, and consequent low standards of living, intensive cropping, soil depletion, and raising refuse-eating animals for replenishing fertility and providing the necessary fats for a dense hard-working population does not complete the explanation of Chinese swine distribution, but it probably is by far the most significant factor.

Around large cities like Shanghai, Canton, and Peiping production of hogs per capita is much heavier than the average for the whole country or even for the less urbanized plains sections. Farmers living near such municipalities find good markets and transportation, two important problems still unsolved in more isolated regions. The three and one-half million folk of Shanghai are said to consume more than one million pigs a year (Lewis J., "The Kiangsu Hog Industry," *The China Journal*, May 1936, pp. 289–308).

In mountain sections rugged topography limits opportunities for crop agriculture. Population is sparse and swine are raised in much smaller numbers than on the fertile valleys of the great rivers. Several such regions stand out on the maps (Figures 3, 4, and 5). Between the Hwang Ho and the Yangtze Kiang stands the Tsinling Shan, an important spur projecting from the central mountain core of Asia and continued eastward as the Hwaiyang-shan. It might be mentioned in passing that this range is extremely important (Tsinling Shan) in China as it separates North China from South China. Between the Yangtze Kiang and Si Kiang spreads a broad area of mountain country sometimes called the plateaus of South China. In the southwest lies the plateau of Yunnan; in the extreme west the borderlands of China include an area of the Tibetan mountain system; and an old massif of

FIGURE 2.—China, political divisions 1930. (After Cressey, George B., "China's Geographic Foundations," p. 54.)

worn down mountains constitutes the heart of Shantung. All these rugged regions have small numbers of people and small numbers of swine.

Aridity and religion combine with rugged topography to account for the sparse swine population in the western and northwestern sections of China. In the three northwestern provinces of Shansi, Kansu, and Ningsia, and the western part of Suiyuan a large proportion of the sparse population is Mohammedan, a religion which forbids the eating of pork. Their meat consists of mutton and beef, products of their dominant pastoral industry, as they are of the similar economy in the comparatively arid provinces of Jehol, Chahar, and eastern Suiyuan where Mongols still lead a nomadic life and follow herds of cattle, sheep, and goats, and pay almost no attention to crop agriculture or swine husbandry.

Dr. J. Lossing Buck in his recently published authoritative study on the land utilization of China states that there is an average of one hog per farm in China, but that the most usual number for farms having swine is two (Figure 6). On farms with hogs the number varies, however, reaching a peak in the Szechwan Rice Region and a low in the Winter Wheat Region of North China. Again a larger percentage of the farms raise hogs in the Szechwan Region than in any other section of China, reaching a figure of 85 per cent. In the Wheat Region, primarily Shansi and Shensi in North China, however, the percentage of farms having hogs drops down to 20. Possibly the large number in Szechwan can be better understood by quoting an excerpt from Little's book "The Far East." In speaking of this province he says: "this country is always green and never without crops; no sooner is one crop ready for reaping than another is seen sprouting in the intervening furrows."

In short, the fact that a larger number of hogs are found in South China than in North China, in rice-growing China (Figure 7) than in wheat-growing China, seems associated with the possibility of producing annually from two to three cultivated crops in the southern rice regions while only one is possible in the colder, less humid wheat region of the north. With heavier production of crops in the south there is more food for more people and they provide a larger total of household wastes for the swine. Also with a heavier total production of field crops in the south, more crop refuse is available for swine feed. Finally with the more intensive use of the soil there is a greater need for fertilizer and the raising of hogs for their manure.

In the final analysis climate is an extremely important factor in this sequence. South of the Tsingling Range the rainfall is heavier and temperatures higher than north of that great division line of China. The climatic advantage

of the south insures heavier crop production which makes possible denser human and swine populations. Moreover, the north suffers greater flood and drought hazards than the south and these limit crop yields and the number of people and swine dependent upon them. Dr. Buck states that in spite of the larger farms of the north there is a greater amount of production on the smaller of the south, due to the possibilities for several crops and the more intensive cultivation.

The number of one or two hogs per Chinese farm seems small to a swine producer from the Corn Belt of the United States where a farm with less than ten to a hundred swine is exceptional. The reason for the contrast is easy to explain. In China the pressure of population upon the land is extreme. In the Corn Belt of the United States much less pressure prevails. In the Oriental country a one-cycle method of food production is necessary. In the Occident a two-cycle production (raising crops and feeding them to livestock which provide food for man) is possible and desirable. In short, the dense population of China must produce the greatest possible amount of food per unit of land in order to survive, even at the low standard of living which prevails. High production can be accomplished best by raising crops for seeds or tuber products instead of feeding crops and pastures to animals which in turn supply a smaller amount of food in the form of animal products.

SWINE FEED AND METHODS OF FEEDING

The nature of the Chinese terrain with dominance of rugged topography and limited plains area necessitates innumerable small holdings in cultivated sections to support the hundreds of millions of people. Owners and renters must all strive to derive the maximum yield from the soil and this major aim prescribes pen feeding for the bulk of China's swine. As previously indicated, in the mind of the average farmer the hog is probably considered a machine or converter into which he puts waste materials receiving in turn manure so indispensable for his crops. The nature of the hog's food and its development are therefore of secondary consideration.

The farmer's first problem is to harvest a full crop and even though large quantities of cereals, legumes, and vegetables are grown, they are seldom fed directly to the swine. It is largely the refuse from field crops and household wastes that form the pig's ration. Bran from hulls of rice, wheat, and corn is often mixed with water reeds—a kind of alga—and fed to the animals. Rice bran, a by-product of rice milling, qualifies well as refuse from crop land, for

FIGURE 3.—Swine distribution in China. Statistics for the map are for 1935 and were furnished by the National Agricultural Research Bureau of China. The writer was guided in distributing the dots by several factors—most important of which were land forms, water bodies, and distribution of human population.

there is practically no demand for it other than for use as hog food. Bean residue from bean curd and sauce and grain residue from making wine are also used rather extensively. Grass and green vegetables, if available, may be used in warm weather. The food is usually fed in the form of swill with table scraps and refuse mixed in water.

When food is available the hogs are given their feed three times daily, and if supplies are plentiful they are allowed to consume all they can eat. Too often the food lacks body-building quality, and, of course, it varies considerably, depending upon what may be obtained. Mr. Lewis believes that low quality of the ration and irregular feeding causes permanent enlargement of the belly with resultant sagging of the back, a characteristic so common among Kang-pei hogs (Figures 8 and 9). Swine are fed in troughs, and self-feeding, so characteristic of the Corn Belt of the United States, is not practised. (Many of the facts in the above description of feed and feeding methods were taken from a letter written by Dr. T. H. Shao of the University of Nanking, who gave the writer other valuable information in response to a questionnaire.)

In any description of Chinese hog husbandry, it is well to note that the term "scavenger feeding," which the writer has applied to Chinese swine production, has a broad rather than a narrow meaning. Household wastes do form an important item in the animal's diet, especially in some sections, but refuse from the fields is equally important if not more so. In fact, many farmers are so thrifty and so poor that few table scraps remain after meals, and the bulk of the pig's ration must of necessity come from crop refuse that cannot be utilized otherwise.

In China, as in other countries, there are special types of feeding besides those followed by the majority of farmers. For example, hogs which are driven to Shanghai for marketing may be kept in pens two or three weeks and fed on concentrated feeds. Again, in traveling in North China the writer saw several groups of swine herded by swineherds upon grazing land. Finally, Dr. Cressey states that in Kinwha, in Central Chekiang, famous for its hams, corn is raised expressly for hog feeding. Nevertheless, the feeding of corn, the rationing of concentrated feeds, and free range on grazing land are not dominant types of swine feeding in China.

SWINE HOUSING FACILITIES

Dr. Shao describes shelter given swine as follows: "The hog shelters are near the residence in a low position, which is wet and dirty. There may be a pan or a trough in front of the shelter where the ash and garbage are dumped. Thus the hogs are able to eat the garbage and manure the ash. The shelter is about three feet in height from ground to eaves, has walls made of mud bricks, a thatched roof, and faces the south, this side having no wall." In this description notable elements are the utilization of local materials for building the hog shelter, the evidence that hog feeding is indeed a scavenger type, and the influence of climate on facing the pens to the south. Hog houses in the Corn Belt of the United States invariably face the south, and thus in both regions, which lie in the north temperate latitudes, advantage is taken of the fact that the sun is always in the southern sky. (A very small portion of southeastern China lies south of the Tropic of Cancer.)

Mr. Lewis writes: "The manner in which animals are housed is by no means uniform. Around Jukao and Nantung, parts of Kiangsu, we commonly find pens laid with a floor slightly above ground level, of close-fitting brick and

suitably drained to an outside kong, where all manure is collected. Walls on three sides are also made of brick, to a height of three feet. A trough of similar material laid V-shape completes a fairly sanitary arrangement. . . . In more southern districts pens are usually constructed of bamboo and mud with undrained mud floors. Straw and fine ash are deposited on the floor from time to time, and allowed to mix with the droppings, while several times yearly the upper few inches of this accumulated filth is removed and used as fertilizer.

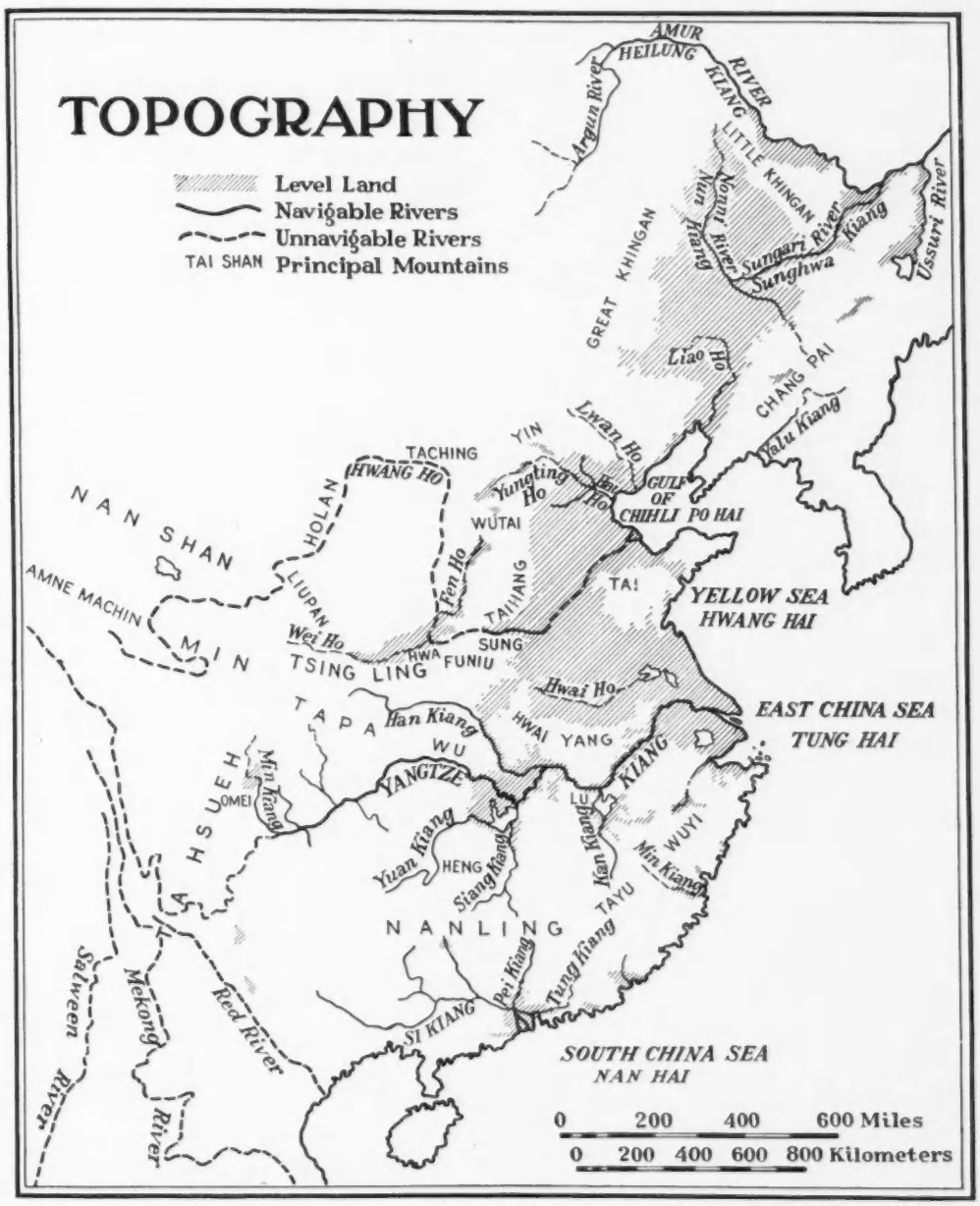

FIGURE 4.—China, topography. Permission for publication was given by Dr. George B. Cressey. The original map appears in "Agricultural Regions of China," Cressey, George B., ECONOMIC GEOGRAPHY, April 1934, p. 110.

In some places pens with a few planks or loosely-laid stone slabs are found. The interiors of pens and troughs are seldom washed or scoured. Animals are given bedding only in cold weather or in the case of farrowing sows. Little attention is paid to lighting or ventilation. It is in such surroundings that hogs are confined, in most cases never leaving the pens until ready for the market. Frequently hogs may be housed with the family under a common roof."

It would seem that whatever the methods adopted for housing swine, all are taken primarily for conserving the excrement and only secondarily for the bodily comfort or well-being of the animal.

MANURE VALUES AND METHODS OF STORING AND APPLICATION

The Chinese farmers of Szechwan have discovered in a land where fertilizer is scarce, and in a country where artificial fertilizer is not manufactured, that the pig in the sty produces from minimum feed costs the highest value of manure for farm and market gardening purposes. They have found, by trial and error, from years of practical experience, that urine is the most valuable fertilizing element of the hog's excrement, as western agriculture has determined in the laboratory. Experiment demonstrates that some of the nitrogenous compounds in the food are completely broken up by the digestive processes and pass off in the urine, while others pass off in the feces little effected by digestion. Further tests proved that the broken-down nitrogen elements in the urine when applied to the soil will change rapidly to ammonia, a very active fertilizer, whereas the nitrogen elements of the feces which resisted the digestive processes, also resist the soil bacteria in their attempt to break down the nitrogenous items and to change them into ammonia and nitrates that can be used for plant food. True, nitrogen from the feces is finally broken down and becomes available for plant growth, but the time element is much longer than that required to break down the nitrogen in the urine. Similar tests were made upon potash and phosphorus elements in the urine and feces with similar results. The liquid excreta proved the most valuable fertilizer in every test.

In Szechwan hog manure is carefully taken from the sty, mixed with wood ashes, stored under cover from the weather, and later used as a dry, soil-like fertilizer and applied by hand to the individual plant—whether it be field cereal or garden vegetable. The urine is carefully drained from the sty into a closely sealed cement-like well. At stated periods the urine is ladled from the well into concrete curing pits. After proper curing of the mixed contents of the curing pits, the fertilizer is ladled into buckets, carried to the fields, adulterated in big wooden tubs, then applied in liquid form to the individual plants, except in the case of rice, where the liquid manure is broadcast through the air from the banks of the paddy-field. Judging by field and garden practices, it seems as though the Chinese of Szechwan have achieved high efficiency in preparing and using manure; some of their methods might well be followed by farmers in other countries where soil fertility must be conserved and improved.

Danish farmers, like the Chinese, are careful to preserve swine urine for fertilizing their fields. I quote from "Swine Industry of Denmark," p. 30, ECONOMIC GEOGRAPHY, January 1938, Shaw, Earl B.: "The water-tight floor of the hog house is necessary to save the liquid manure which is piped direct from the shed to the container outside. Approximately 80 per cent of Danish farms are provided with facilities for saving

liquid animal manure, a fertilizer which contributes significantly to the high crop yields." In Denmark, moreover, the manure is much more valuable as a fertilizer than in China because in the former country the hogs are fed better and more carefully. It has been found that manure from poorly fed animals brought an increase of crop amounting to about 30 per cent, while manure from richly fed animals brought an increase as high as 80 per cent during the first year after application to the soil. Better feeding is also found in the United

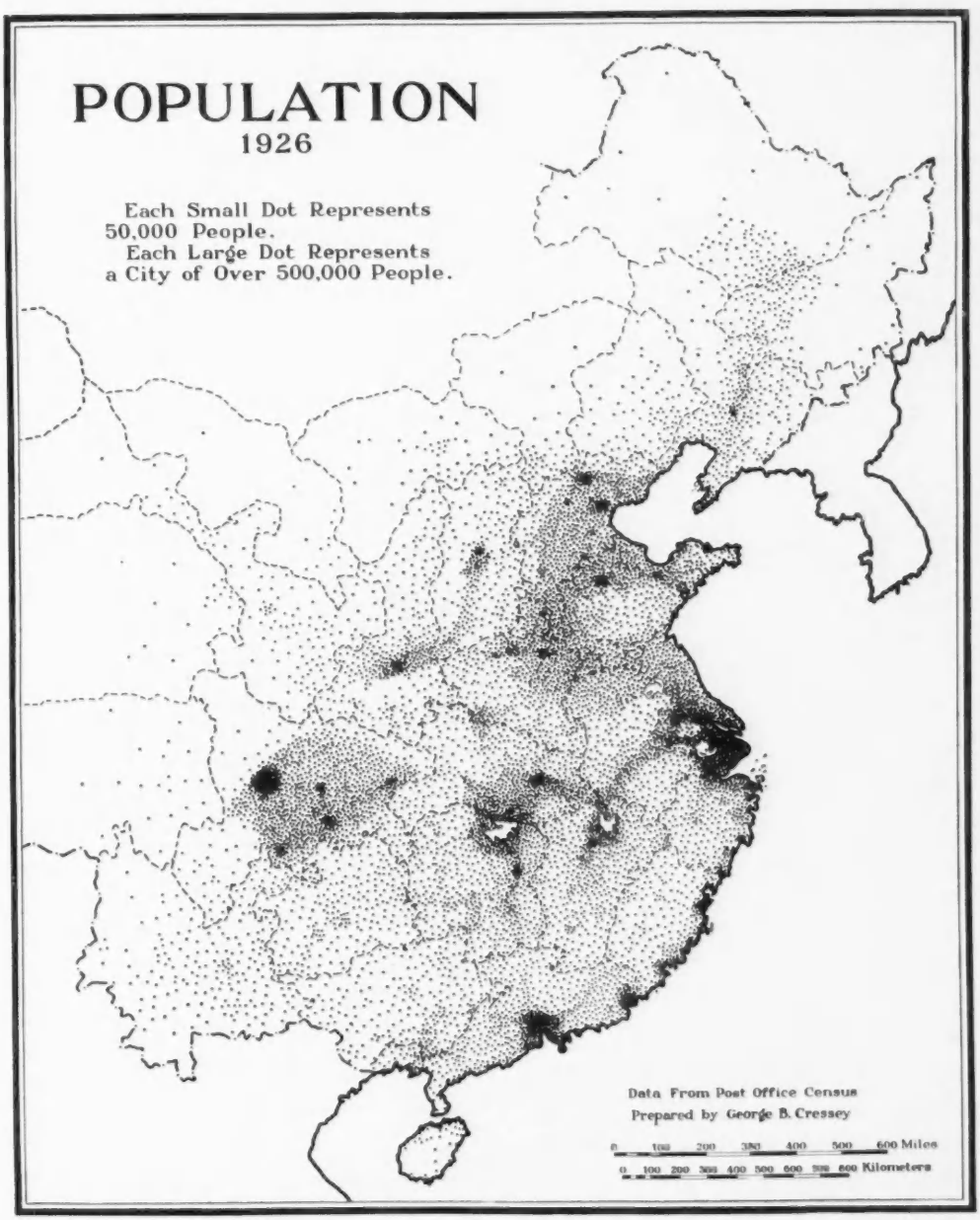
POPULATION
1926
Each Small Dot Represents
50,000 People.
Each Large Dot Represents
a City of Over 500,000 People.
Data From Post Office Census
Prepared by George B. Cressey
0 100 200 300 400 500 600 Miles
0 100 200 300 400 500 600 700 800 Kilometers

FIGURE 5.—China, population. Permission for publication was given by Dr. George B. Cressey. The original map appears in "Agricultural Regions of China," Cressey, George B., ECONOMIC GEOGRAPHY, April 1934, p. 117.

States Corn Belt than in China, but no such care in the preservation of the manure exists in the former country. Though animal manures are used in the United States, commercial fertilizers are available at such reasonable prices that the farmer has not found it necessary to resort to the careful methods of the thrifty Chinese in replenishing soil fertility. (The above discussion concerning the utilization and storing of swine manure in China applies primarily to swine in Szechwan, the province in China which has more hogs than any other, and over one-sixth of the total for the entire country. Variations from these methods are used in other parts of China. The material was taken primarily from a correspondence written by Frank Dickinson, West China Union University, Chengtu, Szechwan, China.)

FIGURE 6.—The most usual number of hogs per farm for farms having them. South China has the largest number per farm, especially in Szechwan and Yunnan. Hogs occur on over 80 per cent of the farms in these two provinces while they are found on only 20 per cent of the farms of Shansi and Shensi. (After Buck, J. Lossing, "Land Utilization in China," p. 117, Atlas.)

SWINE BREEDING

Mr. Lewis states that the animal most generally found on Kiangsu farms today is the native black pig. Since this hog is probably indigenous to Kiangsu and to many other provinces where it is raised, he thinks that it might be called the China black pig. (While traveling through north China the writer saw black pigs of the Kiangsu type.)

The China black pig of Kiangsu comprises three major breeds—the Kang-pei, the Wu-sieh, and the Hai-chou. The Kang-pei (Figures 8 and 9), which predominates, has long, pendulous ears, a long snout, a lean body with sagging abdomen, a prominent spine, lean hams, and long, coarse bristles. The Wu-sieh hog is generally a smaller beast with abdominal and spinal features of the Kang-pei type less pronounced. Its bristles are not so coarse as those of the Kang-pei. The Hai-chou hogs, sometimes called the Shantung or Huaitze, are well-developed, large-boned animals, semi-wild, a foraging type. Their snouts are less prominent and their bristles are longer and coarser than those of the Kang-pei swine. Not many of the Hai-chou hogs are produced.

Although the Chinese early contributed hogs which gave quality to modern breeds of swine, they have not made so much recent progress in swine breeding as have the farmers in Denmark and the Corn Belt of the United States. In the study of Danish swine, stress was laid upon the care with which breeding animals were selected and developed to produce suitable pork to meet discriminating market demands; and how size of litter, cheapness of gain, and quality of product had improved remarkably within the past few decades. In contrast, the vast majority of Chinese farmers are ignorant of what real progress in swine breeding implies. A sow, which may farrow twice yearly, is permitted to produce young time and again until well after the number and quality of the litter have demonstrated her unfitness to continue. Again, the idea prevails

among many Chinese that any boar is good enough for breeding, and consequently it often happens that the poorest specimen is reserved for this purpose.

Mr. Lewis in describing one of these hogs of Kiangsu writes as follows: "At several farms I visited . . . no boar was in evidence, and I learned that it is customary for some impoverished low-class villager to maintain such an animal and to hire it out for a very small fee as its services are required. At a farm on the outskirts of Sung-Kiang I was fortunate in meeting a villager who owned a boar and was invited to accompany him on his rounds for that day. The animal, a lean, wasted-looking specimen, apparently typical of others in service, was secured by a chain and traveled with the owner from one farm to another. Frequently such journeys cover miles in a day." The author was reminded of Caribbean hogs while reading Mr. Lewis' description. In sections of that area it is not uncommon to see hogs staked out with ropes, and sometimes raw sores develop on their necks from friction of the rope.

With careless breeding conditions prevalent in China, little improvement in swine quality is likely for some time. Moreover, probably not one Chinese farmer out of ten thousand can read and write (Lafleur and Foscue, "Agricultural Production in China," ECONOMIC GEOGRAPHY, July 1927, p. 307); hence they can take little advantage of progressive literature sent from experiment stations even if such literature were available for all and the means of transmitting it to the swine raisers were possible. Whenever the farmer can be taught to improve present swine-breeding methods, progress will be made; however, advance will be slow, for customs which have been followed for centuries are not given up easily.

FIGURE 7.—The two main agricultural regions of China. Mr. Buck states that "the boundary of agriculture in the west is determined by high elevation and in the north by meager rainfall. The boundary between the Rice Region and the Wheat Region is the northern limit of rice cultivation." (After Buck, J. Lossing, "Land Utilization in China," p. 9, Atlas.)

SWINE FARROWING

In China, as in the Corn Belt of the United States, the majority of pigs are farrowed in the spring. Dr. Shao states that "60 per cent of the young are born in the spring, 30 per cent in the autumn, and the remainder any time in the year without regard to season." Thus it is seen that climate influences the time of the pig's birth. Chances for saving the young are climatically better, for most of China, during April and May than in fall or winter. Opportunities for feeding are probably just as favorable for spring-farrowed pigs, as for pigs farrowed either during autumn or the coldest season.

From Dr. Shao we learn that the farrowing sow is kept separate from other hogs, usually in a quiet place. At first glance this problem would seem simple when one remembers that the average number of hogs per farm even in Szechwan, the leading producing province, is only slightly above three. However, in this province some specialization has

crept into the industry. A few breeders keep several sows in order to raise pigs for sale at weaning time or shortly after. Mr. Dickinson writes: "In pig raising in Szechwan, China, we find three rather distinct periods: (1) birth to weaning; (2) weaning to the frame growing; and (3) a dual purpose period, in which the pig is used as 'a living fertilizer producing machine,' and in which weight is put on the frame for fresh pork. It is in this final period, when the pig, after growing his frame, gets into the hands of the farmer and the small holder." Thus where several sows are kept primarily for the sale of pigs to farmers at weaning time, the problem of isolating each sow during the period of farrowing may be difficult. It is doubtful, however, that the McLean system of raising hogs (Shaw, Earl B., "Swine Production in the Corn Belt of the United States," ECONOMIC GEOGRAPHY, October 1936, p. 364), which involves a separate house for each sow and a change of each house annually to new ground is followed to any extent in the Orient.

Mr. Lewis states that pigs per litter vary in number from one to twenty with the average about twelve. Dr. Shao does not indicate the number farrowed, but gives six as the average raised per sow. These figures may be correct, but the writer feels that they are not conservative estimates. In fact, he believes that the average number of pigs per litter is probably less than in Denmark or in the Corn Belt of the United States. Basis for this belief may be found by referring to the discussion on swine breeding.

SWINE MARKETING

As indicated throughout the study, the raising of hogs for manure is one of the primary purposes of swine culture in China. Nevertheless, the hog is also of prime importance as an economical producer of lard and pork for food and when mature is killed for family use or sold for market. Where hogs are raised near large cities the factor of production for market may be an important one.

When raised for meat purposes near such cities as Shanghai, swine may be sold to country assemblers who buy hogs from the farmers, either for cash or trade, and drive them to market. Usually for some time prior to removal from the farm the hogs are fed on rough feed to make them drive more easily to the city stock yards. Even when fed carefully they lose considerable weight in traveling over sections where roads are scarce and paths difficult. Moreover, when driven through extremely rugged areas they may suffer bruises and contusions. After arriving at the packing plant they may be fattened for a week or more and then slaughtered.

Hogs may reach market in other ways besides being driven there. Throughout the lower valleys of the great rivers and along the coastal areas where swine distribution is very dense a veritable network of irrigation canals criss-cross the country. Here where roads are few, boats are used for transport. Where the road bed permits, two-wheeled carts may carry animals to market. The wheelbarrow, considered by some as the national vehicle, is also pressed into service to deliver the pig carefully secured in a basket to his purchaser. Finally, Dr. Cressey on page 98 of his excellent study, "China's Geographic Foundations," illustrates another method of marketing swine—namely, trussing them up on bamboo poles and delivering them by human carrier. Thus, cheap human labor, distance, water bodies, and land forms are leading influences upon the transport of swine just as they are upon

the movement of China's other commodities.

Much of the pork of China is packed in the peasant's salt barrel. The farmer usually kills his hog or swine at the time of the China New Year of the lunar calendar. The butcher is called to the home to do the slaughtering. The inside parts of the pig are kept for immediate use, the head is salted for consumption at the hired-labor time, and the rest of the meat is packed or sold.

The peak of swine marketing at Shanghai comes in January and September of each year. The January high is the same as that for the Corn Belt of the United States. In the latter case the heavy shipments are definitely a result of an attempt to get rid of cold weather feeding. In Shanghai most writers associate the January peak with the coming of the Chinese New Year. The author is inclined to think that there may be a strong climatic influence as well. It may be remembered that in eastern Asia the strong monsoonal outpouring of cold air in winter from the large continent in the rear results in the lowest average winter temperatures in those latitudes for any part of the world. For example, Mobile, Alabama, and Shanghai are in approximately the same latitudes, but Mobile has an average January temperature of 51.6 degrees Fahrenheit, while Shanghai's January mean drops to 37.6 degrees Fahrenheit. Thus climate may encourage a January marketing peak in Shanghai just as it does in the Corn Belt of the United States.

The heavy marketing in September may be caused by the same factors which account for a fall peak in the marketing of New England's swine. Many of the hogs raised in this industrial section are garbage fed animals. With the coming of fall the household wastes suitable for hog feed decline rapidly and breeders are forced to market at least some of their swine. A slightly analogous situation may account for the September peak of marketing in Shanghai. Another influence may be the sale of pigs farrowed early in the spring.

Hogs throughout China are probably marketed at much lighter weights than swine of such countries as the United States and Denmark. In Kiangsu province, for example, most of the animals that are sold reach the market at an average age of about six months and at weights approximating one hundred and one catties or 134.3 pounds each (Table I). It may be recalled that the average weights of Danish and Corn Belt market hogs range from 40 to 90 pounds heavier. Causes for the difference are not hard to suggest. Chinese hog food ranks lower in quality and amount than that fed in Jutland and in the Corn Belt. Moreover, Chinese farmers live such a hand-to-mouth existence that they may be forced to sell the animals before they reach maturity.

TABLE I

PRODUCTS FROM AVERAGE KANG-PEI HOG *

Weight: 101 catties
134.3 pounds

Part of Carcass	*Pounds*	*Per Cent*
Hams	25.46	18.95
Bellies	16.64	12.39
Loins	12.85	9.57
Shoulders	32.33	24.09
Head, including tongue and brain	8.71	6.48
Leaf fat (lard)	4.88	3.63
Heart, liver, lungs, etc.	6.83	5.09
Total dressed weight	107.70	80.20
Stomach, intestines, etc.	19.35	14.40
Blood	5.00	3.73
Bristles, hair, hoofs, etc.	2.25	1.67
Total live weight	134.30	100.00

* Lewis, J., "The Kiangsu Hog Industry," *The China Journal*, May 1936, pp. 289–308.

All parts of the hog, including the offal, are eaten or put to some industrial use. The statement that nothing is lost except the squeal which had reference to swine packing in the United States is likewise applicable to the more primitive

pork packing of the Chinese. Certain of the animal's organs are consumed as delicacies, while others are considered to have therapeutic or curative properties. On this subject various superstitions prevail. For instance, belief exists among certain natives afflicted with venereal diseases that the spinal cord prepared with dragon eyes, a small fruit from south China, will cure these complaints. Others affirm that this preparation has tonic properties rivaling those of ginseng.

Pigs' blood is cooked with a little salt,

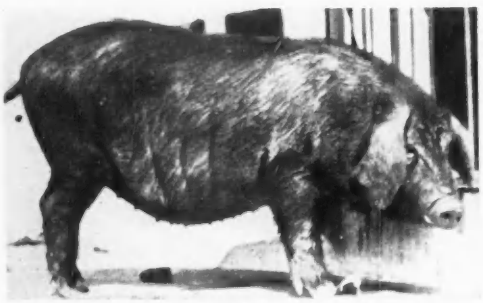

FIGURE 8.—Kang-pei pig. This black pig is typical of those raised in Kiangsu province and similar to many produced throughout China. (After Lewis, J., "The Kiangsu Hog Industry," *The China Journal*, May 1936, pp. 289–308.)

then cut into cakes, and sold for a few coppers each, being somewhat cheaper in summer than in winter for obvious reasons. Some blood is utilized in the paint and varnish trade, and a small amount is used by dealers in market produce for the irregular practice of freshening up the gills of stale fish.

There is a regular demand for lean carcasses for the preparation of dried meat. The article finds a ready sale among Chinese of delicate health. The dessicating process consists of cutting up the meat very fine and boiling it until most of the water has been evaporated and the meat becomes tender. After preliminary drying, the meat is rolled on a specially prepared wooden surface to facilitate the separation of the fibres, which are then finally dried in an oven or in the sun.

The time of slaughtering hogs in Shanghai and in the other large Chinese hog markets reveals an interesting geographic relationship. Hogs are killed between the hours of midnight and 6 A.M. largely because such a procedure assures a fresh product in a country where refrigerating facilities are not as widely available as in the United States. With better refrigeration, less night butchering would be necessary. In a recent year the average daily kill for Shanghai was 3,100 hogs, providing night work for scores of people. The total kill for the year reached 1,128,938.

In the preparation of pork for market, watering the meat is a common practice. Butchers force water into the circulatory system after the animal has been bled and scraped and thus add several pounds to the weight of the carcass. This practice is said to be common in Shanghai, Canton, and other large cities. Where there is a lack of water under pressure, difficulties arise in carrying out the cheat. Carcasses are sometimes watered to destroy evidences of poor bleeding.

SWINE DISEASES

Although irregularities such as those discussed at the close of the last section escape serious penalty in Shanghai, inspection for disease is fairly critical. Two-thirds of the animals condemned are afflicted with cholera, indicating that this plague probably inflicts greater losses on China's swine than any other. It is most common during the spring months, partly, no doubt, an adjustment to the accumulation of dust brought by the outblowing winter monsoon.

In the United States farmers have largely lost the fear of cholera, which was so prevalent a few decades ago, because cheap successful vaccination

has practically banished the disease. Whereas most American farmers immunize their herds regularly year after year, the Chinese farmers know little or nothing of immunization. In fact, it has been said that were it not for the keeping of breeding hogs to an extreme age, the swine industry would have been practically eliminated by cholera in China long ago. This may be explained by the fact that a few hogs survive the malady and gain comparative immunity. If retained for breeders they may be the only ones spared when cholera again spreads through the community.

Though tuberculosis is found among Chinese hogs, it is probably not so common as in American swine because Oriental animals are not fed with milk —a feed which, when carrying infection, transmits the disease to swine in the dairy regions of the United States.

Several parasitic diseases as well as other maladies affect Chinese hogs just as they do the occidental breeds. However, little specific or general information about swine health conditions is available. Those who venture an opinion on the subject believe that the Chinese pig is less susceptible to disease and healthier than his western relative; but such opinions are not backed by satisfactory proof.

EXPORT OF HOG PRODUCTS

Few modern packing houses are found in China, and these only in large cities. As previously indicated, most of the pork packing is done in the farmer's salt barrel. Nevertheless, in spite of the backward state of meat packing, several million dollars' worth of swine products are exported annually, coming from both packing house and farm.

The export of hams is largely from Shanghai, China's largest city, partly because the best inspection is afforded there. Shipment is made to Manila, Hongkong, Singapore, Java, and elsewhere in the Orient, but Manila is the main market. Hams going to Manila are packed in wooden boxes containing a hundred in each with the weight of each ham correctly marked on the outside wrapping.

Hams, however, are a minor export in comparison to pig bristles, the total export of which in 1936 amounted to $25,303,746 (Department of Overseas Trade, Great Britain, Report on Economic and Commercial Conditions in China, p. 28). Bristles are the long straight strong hairs growing along the top of the hog's neck and shoulders. These hairs average about two inches in length. Prices range from ten cents to sixty cents per catty (a pound and one-third) and up to a dollar and sixty cents for the better spinal variety. It seems interesting to note that bristles, a commodity of high specific value per unit of weight and one with excellent keeping qualities, form the most important swine export from China. No doubt this is, to some extent at least, an adjustment to rugged topography and primitive transport. Some dealers go about the country districts buying up small quantities while others purchase from the slaugh-

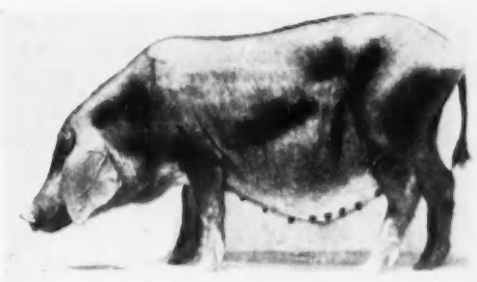

FIGURE 9.—Kang-pei pig. This pig is larger and rangier than the animal shown in Figure 8. Both individuals are from Kiangsu province. Notice the sagging back and belly and the long pendulous ears. (After Lewis, J., "The Kiangsu Hog Industry," *The China Journal*, May 1936, pp. 289–308.)

terhouses found in the major Chinese cities.

Bristles produced in the province of Kiangsu are considered of inferior quality, not to be compared with the product in the colder regions of Manchukuo and Siberia. In Kiangsu, and in fact throughout most of China, it is customary to market hogs while still immature; consequently bristles never attain the length or texture seen in the north where hogs are marketed older and where bristle quality is also encouraged by lower temperatures. It is reported that in Chungking, Szechwan, breeders are emphasizing the production and sale of bristles as a major item in hog raising, and there this phase of the industry is rapidly gaining in importance. The United States took nearly half of China's export of bristles in 1936 with smaller amounts going to Japan, Germany, and France. Most of the supply is concentrated at points in Szechwan and Yunnan and at such cities as Hangkow, Shanghai, and Tientsin.

In importing countries these swine hairs find a variety of uses. The finest quality are used for toilet brushes of all kinds, while those of inferior quality are utilized in the manufacture of paint brushes, matting, carpets, felt hats, and thread for the shoe trade.

Ranking next to bristles in value are exports of swine intestines, which amounted to $10,893,677 in 1936 (Department of Overseas Trade, Great Britain, Report on Economic and Commercial Conditions in China, p. 28). The packing of this product for export is concentrated mainly in Shanghai, Hangkow, and Tientsin. In 1936 most of the production went to Germany and France.

Lard to the amount of approximately two million pounds annually has been exported during the last few years to Hongkong, Manila, and Singapore and other places in the Orient. The tonnage is declining, however, in face of the competition with coconut oil and other vegetable oils which are products of a one-cycle fat production (Shaw, Earl B., "Swine Production in the Corn Belt of the United States," ECONOMIC GEOGRAPHY, October 1936, p. 369).

The most important factor limiting expansion of marketing pork products from China, both for export and local market is need for using land to raise foods for man rather than for animal production. Other retarding factors include inadequate transport, lack of refrigeration, pork of poor and inconsistent quality, and careless preparation of the product.

SUMMARY AND CONCLUSIONS

Swine production of China, a country with approximately one-fourth of the world's hogs, and one in which the animals have long been raised is basically different from that of other countries in several respects. The significance of manure for fertilizer made available by hog raising is probably greater than in any other major hog-producing country. Some authorities go so far as to state that Chinese swine are produced primarily for the manure and that pork production is of secondary importance. Others suggest that the two factors are of equal significance. Whichever is correct, there is no doubt that the hog stands high among China's domestic animals in providing manure for soil building and fills an important place in the nation's agricultural economy. It must not be forgotten, however, that large amounts of fertilizer are obtained from draft animals and from night soil.

Not only do Chinese aims in swine production differ from those of countries like the United States and Denmark, but methods of feeding and the distribution of hogs show striking contrasts. In the United States few hogs are grown in

densely peopled manufacturing regions of the East, but they thrive on maize in more sparsely peopled lands of the Corn Belt. In China, however, fertile river and coastal lands which support a dense agricultural population—the densest in the country—also support the largest number of hogs. Moreover, in rice-growing China where multiple cropping is more important than in wheat-growing China, the number of hogs per farm is greatest, suggesting correlation between heaviest demands on the soil and need for maximum fertilization from greater supplies of swine manure.

While the greatest number of hogs per farm is found in South China, that figure is strikingly lower than the number for farms in the Corn Belt of the United States. There, it is unusual for a farmer to own less than ten to a hundred hogs, whereas Chinese farms with more than three or four are exceptional.

Swine housing facilities emphasize the conservation of manure more than the comfort of the animals. Furthermore, in several sections the value of the urine over feces is well recognized and facilities for storing it are available on many Chinese farms. Such facilities are not characteristic of Corn Belt farms, but approximately 80 per cent of the swine pens of Denmark are adequately equipped for this purpose.

Geographic relationships are numerous in Chinese hog production. Methods of transport to market correlate with rugged topography, dominance of water transport and abundance of labor. Peak season of farrowing is in spring, largely an adjustment to more favorable climatic conditions for growth of young pigs. Cholera cases also reach their highest number in the spring, a condition influenced no doubt by dust accumulation during the preceding winter monsoon. Tuberculosis is said to be less important than in the United States or Denmark, largely because the Chinese cannot afford to keep dairy cows, which sometimes transmit the infection to swine through milk in the feed. Bristles provide the major export product from swine, a commodity with high specific value per unit of weight and one with excellent keeping quality. Numerous other relationships could be cited.

Progress in the raising of animals which grow faster, are more prolific, and more marketable seems likely to fall far short of the great advance made by Denmark. Many conditions tend to prevent such progress: (1) China raises but a small proportion of her pig crop primarily for meat; (2) China is an extremely large and varied country even if one considers the huge slices that have been nipped from her body by the grasping Japanese—size and variety alone work against the coöperative tendency so evident and helpful in Denmark; (3) literacy is low among the Chinese farmers; (4) the great age of China's civilization makes custom extremely important, the Chinese have been much more conservative about changing customs than occidental peoples; (5) lack of government funds and government stability minimize chances for federal aid to swine breeders, whereas national and state aid have been important in swine culture of Denmark and the United States. Other conditions opposing progress could be enumerated.

Finally, the one-cycle food production in China is not likely to change to a two-cycle type so evident in the Corn Belt of the United States. Pressure of population will not permit feeding of crops which will sustain a large number of people to animals of which the meat will provide food for a lesser number. Hence, the present system of hog raising in China is likely to persist until pressure upon the land is lessened or changes in the whole farming system occur.

MINERAL WOOL INDUSTRY OF THE UNITED STATES

William D. Thornbury

MINERAL wool is a fibrous mineral material, resembling loose wool or cotton in appearance, which is made by blowing a jet of air or steam through molten slag. It consists of fine, interlaced fibers composed principally of silicates of calcium and aluminum together with other minor constituents. Because of the high percentage of dead air space in a given volume of wool, it is used extensively for sound and heat insulation.

Mineral wool may be divided into three types according to the raw material from which it is made. These three types are rock wool, slag wool, and glass wool. Rock wool is made, in most cases, from natural siliceous limestones or calcareous shales. In some cases rock wool is made from limestone mixed with clay or shale in the proper proportions. Slag wool is made from blast furnace slag with or without the addition of limestone to temper the charge. Iron, copper, and lead slags are most commonly used in the production of slag wool. Glass wool is made from commercial glass batches. The principal materials which go into the glass batch are silica sand, lime, and soda ash.

Early History of Mineral Wool Production

Information regarding the beginning of mineral wool manufacture is somewhat meager and to a slight degree conflicting. Mineral wool is reported in an article "The origin of Rock Wool," which appeared in the December, 1936 issue of *Store Magazine* to have been made in Wales as early as 1840 and in Germany as early as 1870. (Lang, Herbert, "Designing and Operating a Slag Wool Plant," *Chem. and Met. Eng.*, Vol. 29, 1923, p. 365.) There seems to be a difference of opinion as to when the first mineral wool was produced in the United States. According to a brochure of the National Rock and Slag Wool Association, the first company to manufacture mineral wool in this country was the Salem Mineral Wool Company of Salem, Virginia. This company began the manufacture of mineral wool at Salem in 1887 but closed down in 1891 and did not operate again. According to another source of information, the first mineral wool manufactured in this country was made at Cleveland, Ohio, in 1888. (Thoenen, J. R., Information Circular No. 6984, Dept. of Interior, Bureau of Mines, Jan. 1938, p. 4.) In reply to a questionnaire sent out to the manufacturers of mineral wool in this country, one company replied that it began the manufacture of mineral wool in the 1870's.

It appears, at least, that mineral wool is not a new product. It was manufactured in this country at least fifty years ago. However, the modern industry may well be considered as having begun at Alexandria, Indiana. Alexandria is located some forty miles northeast of Indianapolis. C. C. Hall, a chemical engineer for a St. Louis firm which operated a steel plant there, discovered in the course of his search for a suitable rock for fluxing purposes the peculiar properties of the rock around Alexandria. His first wool was produced upon the property of the steel company, but when it was absorbed by one of the larger steel trusts he was forced to move his equipment. He then organized, in 1897, with the aid of local capital, a com-

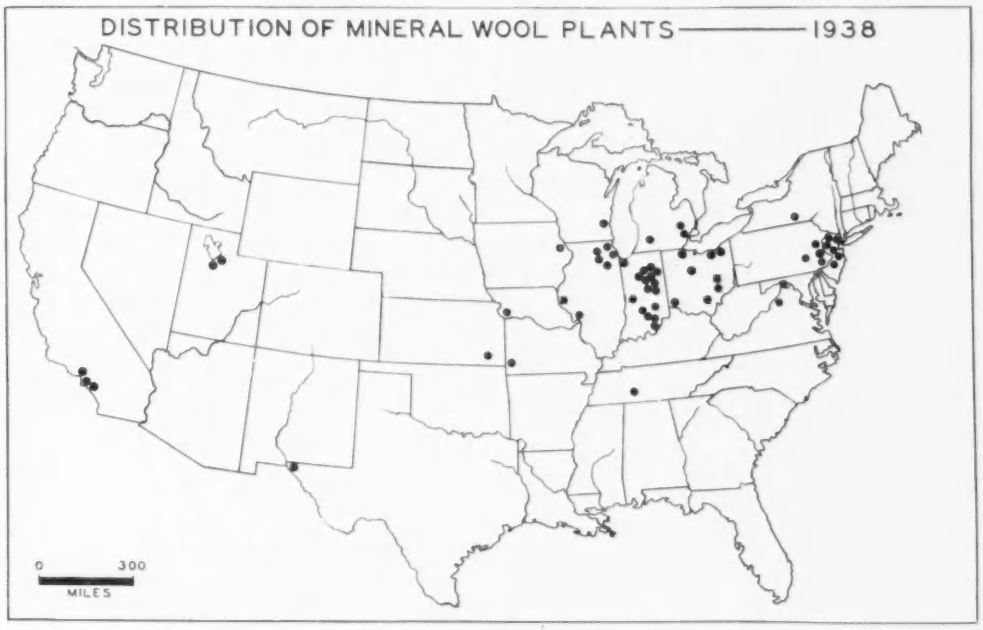

FIGURE 1.—Distribution of mineral wool plants in the United States.

pany known as the Crystal Chemical Company. The company produced mineral wool under this name until 1901 when it was sold to a St. Louis company which was ultimately succeeded by the present General Insulating and Manufacturing Company of Alexandria. In 1906, Hall withdrew from this company and organized the Banner Rock Products Company, which was incorporated in 1906 and began production of mineral wool in January of 1907. This plant which has been in operation since 1907 is now owned and operated by the Johns-Manville Corporation. These two plants at Alexandria are the largest in Indiana today and are among the largest producers in the nation.

RAW MATERIALS

In the early days of the mineral wool industry in the United States, only rock wool was manufactured. The plants at Alexandria, Indiana, used an argillaceous shale or calcareous limestone known to the geologist as the *Mississinewa Shale*. Small amounts of local limestone were usually needed as flux. A typical analysis of the *Mississinewa Shale* is about as follows:

SiO_2	30.89
Al_2O_3	13.21
Fe_2O_3	5.69
$CaCO_3$	28.03
$MgCO_3$	14.32
TiO_2	0.68
H_2O, etc.	5.61

While analyses will vary somewhat with the locality, the formation is remarkably similar in composition over the outcrop area in Indiana.

Rock wool may be made from a variety of raw materials provided the materials supply the proper percentages of calcium, silica, and alumina. Following are some examples of the mixtures of raw materials used by plants which at present manufacture rock wool: (1) limestone, dolomite, and sandstone; (2) calcareous shale and sandstone; (3) dolomite and clay; (4) dolomite and slate; (5) river gravel and limestone; (6) limestone and topsoil; (7) old fire brick, dolomite, limestone, and fluorspar; and

(8) shale and limestone. It is obvious from the preceding list that rock wool can be made from a great variety of raw materials provided they are mixed in the proper proportions.

Slag wool is made from iron, lead, and copper slags with the addition of various types of fluxes. Some of the more common materials added to the slag are limestone, shale, and silica sand. The composition of the slag will determine the type and amount of flux to be added. Two plants report the use of high silica slags without the addition of any flux.

Glass wool is made from practically the same materials as those used to manufacture other glass products. The main ingredients which go into the glass batch are silica sand, lime, and soda ash. Other materials may be added in small amounts. In some instances scrap glass may be added to the mixture.

MANUFACTURING METHODS

Both rock and slag wool are most commonly produced in cupolas. The ordinary cupola in use is a vertical steel cylinder which in most cases is water-jacketed. Brick-lined cupolas were used in the early days of the industry but they have about disappeared. The average-sized cupola is about 4 or 5 feet in diameter and 8 or 10 feet high. These dimensions vary considerably, however. The diameter may be as little as 3 feet and as much as 8 feet. Sometimes the cupola is as much as 15 or 16 feet high. The water jackets around the cupola are from 4 to 6 inches thick.

The usual charge in the cupola consists of alternate layers of coke and rock or slag in the ratio of about one part of coke to three parts of rock or slag. This ratio between the amount of coke and raw materials varies considerably depending upon the type of material from which the wool is made. In some cases the amount of coke is as low as one part to four or five parts of rock or slag and in other cases it runs as high as one part coke to one and one-half parts rock. The proportioning of the charge in the cupola in the better plants is done by weight. In many of the smaller plants, it is done by counting the number of shovels of material.

Blowing tuyeres are placed about two feet above the bottom of the cupola. These average about eight in number. Air is blown through the tuyeres into the cupola by a blower fan at low pressure. The fusion temperature of the material in the cupola varies with the type of material used. It is difficult to get very accurate data upon the fusion temperatures in the cupolas. In fact, in only a few cases can the producers of rock and slag wool tell accurately the fusion temperature in the melting zone within the cupola. This is due in most cases to lack of adequate apparatus for its determination. Many of the producers indicated that they did not know this temperature or gave figures which were intended merely as estimates. The estimates of the fusion temperatures ranged from 2,300 Fahrenheit to 3,600 Fahrenheit. According to Thoenen, the average for several lead slag plants which he studied was 3,350 Fahrenheit; for rock wool plants it was 3,070 Fahrenheit; and, for iron slag plants it was 2,900 Fahrenheit.

The bottom of the cupola has drop doors to facilitate the cleaning out of the cupola. This has to be done on the average about once weekly. The capacity of the cupola varies from about 500 to 1,500 pounds of wool per hour. Most of the plants consider that they are doing very well if they average 800 to 900 pounds per hour. A production of about 10 tons per cupola per 24 hours would probably be a fair estimate of the average plant capacity.

Unconsolidated fine materials cannot

be used in the water-jacketed or brick-lined cupola because of the difficulty of forcing air through such materials. The material used in the cupola must be of a size large enough to permit the ready passage of air and cupola gases through it. Recently the reverberatory type of furnace has come into use in the production of rock and slag wool as well as in the production of glass wool. This type of furnace permits the use of fine material since furnace gases do not have to pass through the furnace of the reverberatory type.

BLOWING WOOL

The molten material issues from the cupola in a small stream varying in diameter from one-half to three-fourths of an inch. In some cases more than one stream of slag may come from the cupola. As the molten slag falls from the hole in the cupola, it is broken by a steam or air jet at a pressure varying from 80 to 150 pounds. The slag is broken into small globules which while still molten are rapidly propelled through the air. This comet-like propulsion through the air results in the slag being drawn out into fine threads or fibers. Some of the material may not be drawn out into a fiber before solidifying. This material forms the so-called "shot" which occurs in the wool as globular beads of glassy texture. The shot particles vary in size from almost microscopic dimensions up to diameters of as much as one-eighth of an inch. Thus far it has been most commonly the practice of the industry to remove the shot after formation rather than prevent its formation. This practice has been followed largely because the factors responsible for the formation of shot are not clearly understood. Shot is apparently due to the slag globule cooling in its passage through the air to the point of solidification before being all drawn out into fiber. The formation of shot seems to be related in the main to the composition of the charge in the cupola and to the pressure of the air or steam jet. The manufacturers of glass wool seem to have less trouble with the formation of shot than the producers of rock and slag wool. This may be due to their different method of blowing wool or to better control over the composition of the glass batch than the rock and slag wool manufacturers have over the composition of the slag in cupolas. Shot is a waste product and every ton formed means loss of the money required to quarry and fuse an equivalent amount of raw material. Incidentally, one of the advantages which the reverberatory furnace has over the cupola is that it permits the re-use of the shot, since the small size of the shot does not prevent its use in the reverberatory furnace.

FIGURE 2.—Blowing wool from cupola into wool room. (Courtesy of General Insulating and Manufacturing Company.)

Shot has no insulating value, hence its presence in wool reduces its value for insulation purposes. Since most plants have failed in their attempts to prevent its formation, it is necessary to remove it after formation. This is done by

passing the wool through a machine much like a grain separator which effects a mechanical separation of the shot from the fiber but in so doing breaks the fibers. This reduces the binding power inherent in long fibers. From this standpoint, it would be very desirable to prevent the formation of shot.

Shot losses average about one-third by weight. A ton of wool as it comes from the wool house as what is called loose wool will when passed through the granulator for the removal of shot lose as much as one-third in weight. It is the loose wool which has not been treated for shot removal which is best suited for fabrication into dimension materials. The granulated or shot-free wool is not as well suited for fabrication because of the broken fibers. As a result of this some of the smaller plants, which due to less efficient equipment or technique form a large amount of shot in the blowing of their wool, produce only loose wool or granulated wool.

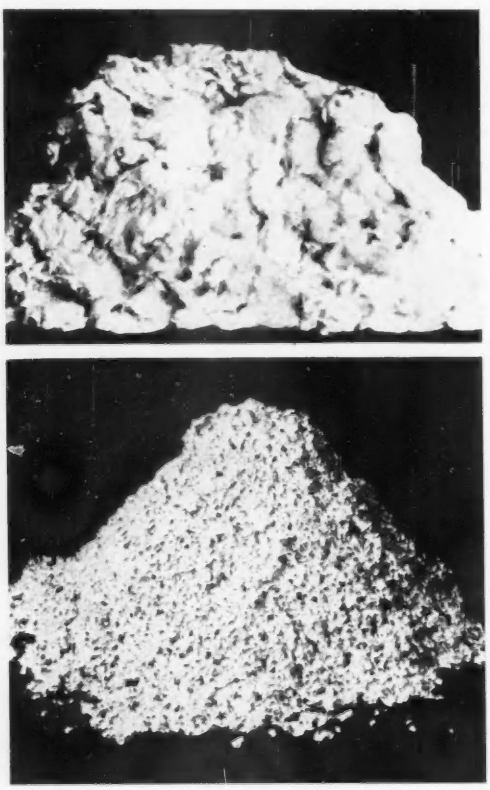

FIGURE 3.—Mineral wool products: upper, loose wool; lower, granulated wool. (Courtesy of General Insulating and Manufacturing Company.)

It would seem highly desirable to the industry to improve the technique of blowing wool so as to eliminate shot formation or at least reduce it to a minimum. There is need for research along this line. Doubtless, much of the trouble could be avoided if there were better control over the composition and temperature of the slag as it issues from the cupola. Shot formation also seems to be affected by the pressure of the air or steam jet. Further research along this line is needed. Not only would the elimination or reduction of shot result in an economy of fuel and raw materials, but it would also provide a better quality insulating material. A better control over fiber size is also desirable. Theoretically, a long-fibered, small diameter wool seems most desirable. The smaller the fiber, the greater will be the percentage of dead air space. The longer the fiber, the better will the wool hold together and retain its shape when put in place.

The wool is blown from the cupola into a wool room. In the early days of the industry wool was collected and bagged in the wool room by hand. This practice is still followed in some of the small plants. Two wool rooms are generally needed, so that while one is being emptied the other can be filled. The wool rooms vary greatly in size. They generally are from 6 to 12 feet wide, 50 to 60 feet long, and 20 to 30 feet high. In the better plants, the wool which is blown into the wool room falls on a conveyor floor of some type. This floor is most frequently made of wire mesh or metal-covered wood slats. The rate of movement of the conveyor floor can be

varied to suit the needs. Generally the rate of movement varies from 1 to 20 feet per minute. The wool is carried by the conveyor floor through a set of rollers which compress the wool into a blanket or roll. The thickness of this roll is determined by the rate at which the conveyor floor moves. If the wool does not have too much shot in it, it may pass on directly to a set of saws and knives which cut it into required dimensions. If an excessive amount of shot is present, it will pass through the granulator for the removal of shot.

The average amount of loose wool produced from a ton of rock is about 1,250 pounds of wool to a ton of raw material. The principal weight loss is in the carbon dioxide and moisture. Subsequent removal of shot may further reduce this as much as one-third. Slag wool will yield a larger return in wool to the ton of raw materials depending upon the type of slag used. The yield of slag wool may run from 1,500 to 1,750 pounds of wool to the ton of raw material. Glass wool will give even larger yields, being theoretically as much wool as material entering the furnace.

GLASS WOOL

"Glass silk" was made in Germany as a war necessity and since 1930 has also been made in England and the United States. Two companies are now manufacturing glass wool in the United States for insulation purposes. One plant began manufacture in 1935 and the other in 1936. The raw materials used are practically the same as those used in the manufacture of glass. Silica sand, lime, and soda ash are the chief ingredients. The materials are shipped to the factories and stored in hoppers which facilitate the measuring of predetermined amounts of each ingredient. The raw materials move from the batch house to the glass furnace by means of an endless conveyor. The glass furnace is of the reverberatory type, which permits the use of materials of any size. Gas is used to maintain the high temperatures necessary for fusion in the glass furnace.

The molten glass flows from an orifice at the end of the furnace opposite that which receives the material. This molten glass is acted upon by steam at high pressure which draws the glass out at a rapid rate into its fiber form. The manufacturers claim that they can control definitely the diameter of the wool fibers. Fibers ranging from .0003 to .011 inches in diameter can be produced. The technique in the glass wool plants after the glass fiber is made is much the same as in the rock and slag wool plants. The wool is gathered on a conveyor belt and pressed into rolls from which the various types of insulating products are made.

The chief advantage which the producers of glass wool possess is the more perfect control over the composition of the glass batch from which the wool is made. This permits them to produce a wool which is nearly free of shot and of very uniform diameter and fiber length. Glass wool has a very pleasing uniformity of color and texture. The idea that the best wool is light in color has become rather strongly implanted in the trade. This requirement the producers of glass wool can very easily meet. However, it is questionable whether the color of the wool is of great importance. Since mineral wool is usually placed in covered places, color would seem to be of little significance. The insulational value of mineral wool depends upon the dead air cells in the wool, not upon its color. The wool might be black as far as its insulational value is concerned. It is not surprising that the large producers of mineral wool should in their advertising play up

strongly the item of color, since their plants are usually better equipped to produce a uniform, light-colored wool.

VARIETY OF PRODUCTS

In the early days of the industry, most of the wool produced was either loose or granulated wool. Many of the small plants which operate only one or two cupolas still manufacture chiefly these types of products. The term loose wool is applied to the direct product of the cupola or furnace without any subsequent treatment. It is the material from which all other types of mineral wool products are made. It may be used as such for insulation purposes in houses where a loose insulating material is needed. Granulated wool is made by removing the shot from loose wool and rolling the broken fibers into small pellets. This type of material is also widely used where a loose insulating material is needed. It can be poured directly from bags or blown into spaces. Granulated wool is packed in standard-sized bags weighing 35 pounds each.

Mineral wool is also fabricated into many forms to meet special needs. Loose wool may be mixed with a suitable binder and pressed into desired thicknesses and cut out into any size or form. This type of product is generally spoken of as bats or blocks, depending upon the thickness of the wool. Blocks are made in varying sizes but their thickness seldom exceeds 2½ inches. They are used mainly for oven insulation, stove insulation, hot air furnaces, and other light-heated equipment. They are also used in refrigerators. Bats are similar to blocks in shape but are thicker. They are used where thicker insulation is needed, as in houses, where they may be inserted in the walls, floors, or roofs, between studding, joists, or rafters. Bats may be made with or without paper covering.

Loose wool, treated or untreated with a binding material, may be placed between chicken wire and metal lathes or other retaining media. This type of product goes by the name of blankets. These may be cut into various sizes and thicknesses to suit the customer's needs. In new buildings, these may be placed directly on or between studding. When metal lathes are placed upon one side of the blanket, the plaster is put directly on one side of the blanket. Blankets are also used to insulate baking ovens, boilers, and furnaces. Bound, compressed, and made to size, mineral wool is also made into rolls, which may be handled as loose wool is handled or as a blanket material. The rolls may be placed between paper or cloth and stitched much as real woolen blankets are stitched. These are used where a flexible blanket material is needed.

Other forms in which mineral wool is produced are: rock wool cement (mixed with asbestos or clay); pads; panels; plaster; brick; felt; cork board; and, acoustic blankets, pads, and panels.

The manufactured products of the mineral wool industry may be roughly classified as one-third loose wool, one-third granulated wool, and one-third fabricated products.

RECENT GROWTH OF THE INDUSTRY

The industry has grown at a phenomenal rate in the last ten years. As nearly as can be ascertained, there were only three plants manufacturing mineral wool as late as 1907. By 1929, the number had increased to ten. Four of these ten were in Indiana and there was one each in California, Illinois, Michigan, New Jersey, Ohio, and Wisconsin. By 1935, the number of plants had increased to about thirty-eight; by 1937, the number was fifty-two; and, in 1938, as nearly as can be determined there are fifty companies in existence operating

fifty-nine plants in the United States. In addition there are at least fifteen companies which sell mineral wool products that do not operate their own plants but buy wool from other companies. Out of forty-five companies giving the date at which they began production, twenty-eight had begun operation within the last five years. In Indiana, the leading state in the production of mineral wool, the number of plants has increased from four in 1929 to sixteen in 1938.

The distribution of the mineral wool plants in the United States is shown in Figure 1. The following list gives the number of plants by states in the United States. This list is up-to-date for early 1938, but a few months may change it.

	Plants
Indiana	16
Ohio	8
Illinois	7
New Jersey	6
Pennsylvania	4
California	3
Michigan	3
Utah	2
Missouri	2
Texas	1
Tennessee	1
Kansas	1
West Virginia	1
Virginia	1
New York	1
Wisconsin	1
Iowa	1

In addition to this list for the United States, there are at least three plants operating in Canada. These are located at Thorold, Asbestos, and Brantford.

The industry in this country is served by the National Rock and Slag Wool Association, which was organized in 1934 under the N.R.A. code. In 1937, there were thirty members of this Association, twenty-five of whom were producers of mineral wool. This Association claims to represent 95 per cent of the production of the industry, but this seems very doubtful, although it does include most of the large producers in the industry. Under the N.R.A. code a price of $50 for loose wool and $70 for granulated wool was established, but these prices have not been maintained because of competition from non-members. The Association collects data upon production from members of the Association and sends out regular reports upon production and sales.

There has been apparent a very noticeable trend toward decentralization of the industry within recent years. As compared with 1929 when there were ten plants operating in seven states, four of which were in Indiana, the fifty-nine plants operating in 1938 are distributed among seventeen states. Indiana is still the leading state, having twice as many plants as its nearest rival, but it does not occupy as dominant a position in the industry as formerly. This tendency toward decentralization is due mainly to the high freight costs upon mineral wool. The costs are especially high because mineral wool is a very bulky material in proportion to its weight. A standard box car will handle about twelve tons of wool. The following

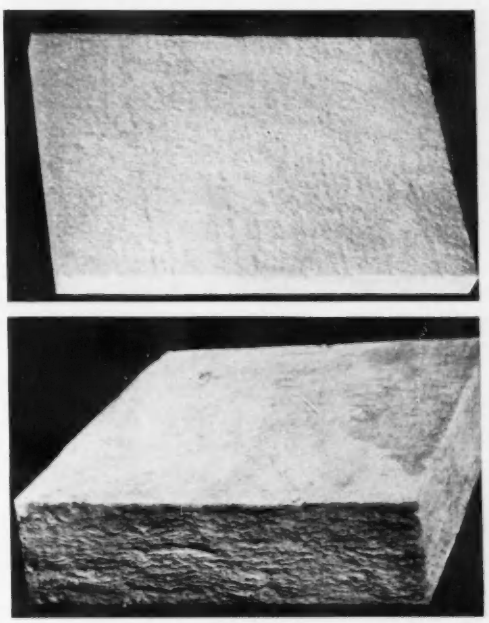

FIGURE 4.—Mineral wool products: upper, block; lower, bat. (Courtesy of General Insulating and Manufacturing Company.)

freight rates (Mineral Yearbook, 1936, p. 1,067) on mineral wool from Alexandria, Indiana, to various points in the United States will readily show why many of the companies have found it advantageous to locate in other states.

Freight rates from Alexandria, Indiana to:

	Per Ton
Chicago	$4.80
Cleveland	5.80
Baltimore	9.00
Philadelphia	9.40
New York	10.00
Birmingham	19.40
Los Angeles	52.80

The fact that mineral wool is now being made from a great variety of raw materials further encourages this tendency toward decentralization. Several of the older companies have established branch plants in other states than those in which they began operation. As examples of this policy, one of the large companies operating at Alexandria has recently established branch plants at Dubuque, Iowa, and Dover, New Jersey and the other company at Alexandria has plants at Manville, New Jersey, and Waukegan, Illinois.

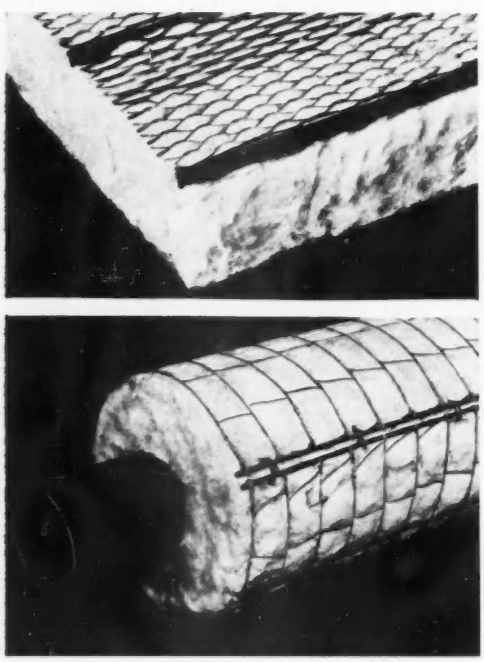

FIGURE 5.—Mineral wool products: upper, blanket; lower, pipe covering. (Courtesy of General Insulating and Manufacturing Company.)

Another notable change in the industry within recent years has been the production of greater amounts of slag wool and the beginning of the production of glass wool. Rock wool no longer dominates the industry. Of forty-three companies which stated the type of raw materials used, twenty-three produced rock wool, seven produced wool from slag and rock mixtures, thirteen produced slag wool, and two produced glass wool. Thus, nearly as many companies produce slag or glass wool as produce rock wool.

It is estimated that the fifty-nine plants operate approximately two hundred cupolas and furnaces. If ten tons per day be taken as an average cupola capacity, it will be seen that these plants have an annual potential capacity of better than 700,000 tons of wool. This is probably a conservative estimate of their capacity. The Bureau of Mines estimates the production for 1936 at 500,000 tons of mineral wool of all types. The average number of cupolas in forty-six plants which reported this item is 3.4 per plant. The number of cupolas per plant varies from one to fifteen.

The industry does not employ a very large number of men in proportion to the value of its products. A large part of the labor is done mechanically. The average number of men per cupola for twenty-six plants which replied to this question was twenty. This would indicate the employment of some four thousand employees by the industry.

VALUE OF MINERAL WOOL PRODUCTS

It is extremely difficult to get very accurate data upon the value of mineral wool products, as most of the producers are very secretive as to the amount of

wool which they are producing. This is probably due in part to the fact that the industry is a relatively new one and one which is growing rapidly. The producers are jealous of their rank in the industry and are probably anxious to keep down competition that might result if it were generally known how great the market is for mineral wool products.

About the only estimates on the value of annual production are those available in the Biennial Census Reports. The Bureau of Mines has in recent years made estimates upon tonnage production, but these do not allow of a very accurate estimate of the value because of the wide range in the price of the different types of products. The following table taken from the Census Reports shows the striking growth of the industry within the last decade:

Year	*Estimated Value of Mineral Wool*
1900	$60,000
1910	84,000
1929	2,377,324
1931	2,873,230
1933	1,714,171
1935	7,672,096
1936 (estimate)	14,000,000

The estimate for 1936 probably represents a minimum for that year. If the tonnage estimate of the Bureau of Mines of 500,000 tons for 1936 is correct, the value of the products for 1936 will run considerably above $14,000,000. The decline in 1933 was attributable to the depression but since that year the industry has steadily forged ahead. No estimates are available for 1937, but the production of that year should surpass that for 1936 if the number of plants in operation is a fair criterion of production. There were at least six more plants in operation in 1937 than in the preceding year.

The Biennial Census Reports estimate the value of the different kinds of wool in 1935 as follows: rock wool at $3,357,526; slag wool at $1,184,946; and glass wool at $3,129,624.

In 1931, "American Builder and Building Age" forecast an annual market for 11,700 million cubic feet of insulating material. It estimated that mineral wool should be able eventually to capture about one-half of this market and thereby become a $100,000,000 industry. Recent growth of the industry seems to indicate that this prophecy may be realized before many more years have passed. A growth from a two-million-dollar industry to a fourteen-million-dollar one in seven years must surely be taken as indicative of rapid growth.

SOME PROBLEMS OF THE INDUSTRY

Although the future of the mineral wool industry seems very promising, there are certain problems of the industry which may be briefly considered. In the first place the industry is already a highly competitive one. There is competition within the industry between the three types of mineral wool which are now being manufactured. Naturally claims and counterclaims will be made as to the alleged superiority of each type of wool. These need not be considered here except to say that first quality wool of either type has high insulational value. Besides the competition between rock, slag, and glass wool, there is within the industry strong competition between the large and small producers. To a certain degree the mineral wool industry is attractive to the person or company with limited capital. It does not require a very large outlay of capital to start production. No very definite figures are available as to the amount of capital necessary for the installation of a plant. The cost will vary considerably depending upon the quality of the equipment. A one-cupola plant capable of producing ten to twelve tons of wool per day will generally cost from $20,000 to $60,000 depending upon the type of equipment. There are many small plants that must

have cost even less than $20,000, but they are in general less efficient and usually are limited to the production of loose or granulated wool. This fact will prevent any company or small group of companies from getting control of production. The failure of the national association to maintain certain minimum prices established under the N.R.A. code was as much related to this condition as to the breakdown of the N.R.A.

Another factor which will tend to attract many producers into the industry is the fact that mineral wool can be made without a great amount of technical skill. While it is of course true that those plants with the better equipment and more skilled operators will produce a better quality wool and with less waste from shot formation, it is also true that a poorly equipped and manned plant can produce mineral wool of a sort. Naturally, those plants with cheap equipment and cheap labor can sell their wool at lower prices. In fact, at the present time some of the small producers sell wool to the large corporations for sale under their own trade names. It is a significant fact that there have been a large number of one and two cupola plants built within the last few years.

In the early days of the industry, it was thought that mineral wool could only be made from certain geological formations like the *Mississinewa Shale* of Indiana. It has become definitely established within recent years that mineral wool can be made from a great variety of raw materials. This fact is undoubtedly going to further decentralize the industry. It would seem very likely that many small plants using local materials are likely to continue to be built. These plants will have the advantage of large savings in freight and will be able to make money on a small scale. Their markets will probably be limited largely to the sale of loose and granulated wool. It does not appear likely that any concern will be able to dominate the industry through control over basic raw materials.

A factor which may help to prevent over-expansion of the industry is the patent situation. The production of loose or granulated wool can be undertaken by any concern desiring to enter the industry, but it seems likely that the demand for this type of insulation may decrease in the future. This type of insulation is in great demand for old houses since it can be blown or poured into the insulation spaces, but new houses will use mainly fabricated products made to specification. The injection of sizing and waterproofing agents into the wool is covered by patents in most cases. The inability of new concerns to secure the use of these patents may act as a check against over-expansion.

Another phase of the industry which may mean the difference between success and failure in the future is the marketing end. As the markets become more saturated, as they must become if the industry continues to expand at the rate that it has for the last ten years, those companies with well-organized sales and advertising agencies are more likely to get most of the market except that in the immediate locality of the plant.

Finally, there are many technical problems which the industry has yet to solve. Among these are such problems as the elimination of shot in the blowing of wool, better control over fusion and blowing temperatures, improvement in blowing technique so as to have better control over the diameter and length of the fiber, and determination of the best type of cupola or furnace to use. The industry has needs for much research. As yet only a few of the larger companies are carrying on any definite research programs.

BLUE MOUNTAIN COFFEE OF JAMAICA

Harry E. Hoy

THE coffee plant was introduced into Jamaica early in the eighteenth century, during the period of general dissemination of the tree from the eastern to western hemispheres. The cultivation of coffee increased rapidly and steadily until 1814 when 34,000,000 pounds were exported. The occurrence of floods and hurricanes during and immediately following 1815, together with the abolition of slavery, caused most of the large plantations to be abandoned.

FIGURE 1.—Bird's-eye view of a Blue Mountain coffee plantation. Note the narrow mountain trail with hairpin turns in the distance. The factory with barbecues or drying floors is in the foreground.

At the present time Jamaica furnishes 0.3 per cent of the world's coffee and ranks 16th among the exporting countries. The normal annual export averages about 10,000,000 pounds although slightly less than 8,000,000 pounds per year have actually been shipped in the last ten years. The Blue Mountain coffee, to which this paper is devoted, accounts for only 2.5 to 3 per cent of Jamaica's production. The annual production therefore amounts to only about 250,000 pounds, an insignificant figure in comparison to the world's total. There are two other coffees grown bearing the name Blue Mountain, Blue Mountain Valley and triage. These are grown at altitudes below 5,000 feet and do not compete with the true Blue Mountain because of their lower quality.

PRODUCING AREAS

This fine coffee is produced on lands from 5,000 feet to the tops of the highest peaks in the Blue Mountain system of eastern Jamaica (7,360 ft.). The farms or plantations are located on the southern or leeward slopes. The two parishes of St. Thomas and St. Andrews produce the bulk of the high-grade crop, as they occupy the leeward sides of the highest elevations.

CLIMATE

The climate on the southern slopes of the Blue Mountains is probably unsurpassed for the production of coffee. The precipitation, mainly orographic and brought by the northeast trade winds, is sufficient on the leeward slopes at high altitudes. There is too much rain on the windward side where the annual precipitation is over 200 inches in many places. The leeward slopes are not as dry as might be expected in the trade wind belt because the Blue Mountains are composed of a series of peaks reaching elevations as high as 7,360 feet but separated by passes whose altitudes are from 2,000 to 5,000 feet. There are two wet periods, one less wet, and one relatively dry period during the year, although no month is entirely rainless. The annual precipitation at Hill Gardens (altitude 4,907 ft.) in the Blue Moun-

tain coffee region is 105 inches. The northeast trades are the most active and bring the heaviest precipitation from March to June and September to December. The equatorial calms of June, July, and August favor sufficient convectional rainfall to carry the crop through the summer months. The clear cooler calms of the low sun period from December to March bring drier conditions which aid in ripening and drying the crop, and also give the coffee tree a chance to overcome some of the fungus diseases which thrive in the warm humid air of the rainy seasons. The fact that mists, cloud, and fog cover the sun during the warmest part of the day, together with the high altitudes, make shade for the trees unnecessary. The temperatures are quite constant, both seasonal and diurnal. At 7,000 feet the extremes of temperature vary from 55 to 70 degrees while at 3,000 feet, they vary from 68 to 82 degrees Fahrenheit.

FIGURE 2.—Closeup of a Blue Mountain coffee tree whose nearly ripened berries await picking.

SOILS

The soils of the Blue Mountains are quite varied. The parent materials consist of limestones, shales, conglomerates, and basaltic lavas. The soils developed on the basaltic lavas and limestones are friable and allow good subsoil drainage with less surface erosion. These soils also allow uncramped tap root development which is a requirement for successful coffee growth. The basaltic soils are basic and are high in phosphorus, iron, and potassium but become deficient in nitrogen rather early, unless animal or commercial fertilizers are applied.

CHARACTERISTICS OF COFFEE

The Blue Mountain coffee tree belongs to the species *C. arabica*, the same variety as is grown on most parts of the island, as well as in most coffee producing countries. The rare flavor of Blue Mountain coffee then is not due to the species grown, but seems to be a combination of altitude and peculiar soil and climatic conditions, where growth is uniform but slow. The coffee bean has a blue green color that makes a good appearing roast. It is bullety, and the seed contains much oil. The caffeine and acid content is quite high. Due to its outstanding quality, the finest coffees of the world are compared with it. It is said that Misor coffee from Nilgire, India, compares favorably with the best Jamaican coffees.

PLANTATION PRACTICES

The coffee plantations are predominantly small. They are usually less

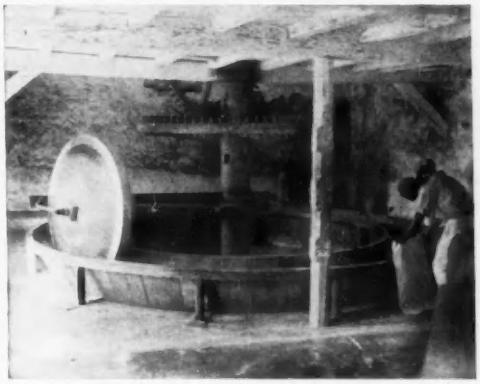

FIGURE 3.—Pulping machine for the removal of the dried pulp coating of the coffee beans.

than 100 acres with the majority under 50 acres. The larger holdings are remnants of still larger plantations owned by an absentee landlord and under the direct supervision of a resident overseer. There are many small holdings owned by the native occupants. These producing areas grow sustenance crops for the owner's family, in addition to the cash crop coffee. The estates are situated on such steep slopes that cultivation is very difficult. The steepness of the land makes hand labor necessary for all operations. Road-building is so expensive that the poorest transportation facilities in Jamaica are found in the Blue Mountains. The most common method of transportation for man as well as for freight is by horse or donkey along the narrow mountain trails.

The crop ripens and is harvested during the dry period from December to March. As might be expected, the yield is small, averaging less than 90 pounds per acre. The preciousness of the product allows no waste or consumption on the plantation. An observer in the area was told by the overseer of a plantation that to his knowledge not a berry of Blue Mountain coffee had been consumed on that plantation in the forty years he had served. Intensive methods are employed in gathering, cleaning, and drying before the coffee is transported by pack animal to Kingston where all Blue Mountain coffee is graded and nearly all is shipped direct to England. There the coffee is used as a blend and is marketed under several trade marks. In 1936 a Jamaican firm began roasting a small amount for local consumption.

PRICE

At first thought it is rather unusual that the price of Blue Mountain coffee has remained nearly constant while at the same time there have been great price fluctuations in other coffees. This is due largely to the small offering each year and to the limited area for expansion. Since 1895 the prices at Kingston have fluctuated between $25 and $50 cwt. The number one grade has suffered less fluctuation.

FUTURE

What is the future of Blue Mountain coffee likely to be? With a market price as much as five times as great as for ordinary grades, it would seem that there would be a rapid expansion and increased production of this coffee. However, several unfavorable factors exist which prevent overproduction. In the first place the potential area at altitudes above 5,000 feet is distinctly

FIGURE 4.—Closeup of a barbecue in use. This is Blue Mountain coffee drying.

FIGURE 5.—Blue Mountain coffee undergoes careful grading to assure that only selected grains go into the sack for marketing.

limited. The ruggedness of the land renders much of this potential area impossible for cultivation. The cost of cultivating this steep land is higher than the cost where machinery can be used. The yield per acre is much lower than that from plantations at lower altitudes. The labor supply is adequate but the wages are relatively high. Experiments have been conducted at lower altitudes to increase the yields with applications of sheep manure. An application of two pounds of fertilizer per tree per year steadily increased the yield from 220 pounds to 580 pounds per acre in a five-year period. If sheep could be made to thrive in the Blue Mountains, an important side industry to coffee production would be developed, as nitrogen is one of the elements most lacking in the soil of the region.

SUMMARY

In summary there are a number of reasons for the high rating given Blue Mountain coffee. A rich friable and basic soil which is conducive to good coffee is found in the Blue Mountains. There is a fortunate combination of favorable temperatures and well distributed rainfall. There is a good soil and climate at altitudes most favorable for slow growth of fine coffee. A relatively plentiful supply of intelligent labor lives in the Blue Mountains. A scientific system of sorting and grading is carried on. Jamaica has enjoyed a more stable government than any of its neighbors in Latin America. England, who furnishes the market for all Blue Mountain coffee, has not been cut off by wars or other disturbances. A preferential tariff by the United Kingdom has given Jamaica an economic advantage over other West Indian Islands. There is a progressive and interested governing country ready to aid and improve both quality and quantity. Blue Mountain coffee has been able without ballyhoo of advertising to reach its high place in the coffee world.

SOME RECENT TRENDS IN ALASKAN COMMERCE

Willis B. Merriam

ALASKA has been characterized as a "last frontier," and as is characteristic of a frontier, is still in a stage of extractive and exploitive economy.

There is no way of accurately determining the total contribution that Alaska has made to the world's wealth. For 126 years Russia drained its fur resources. Since 1867 and United States control, minerals and fish have been the most profitable sources of wealth, and the fur trade which invited the swarming of the "promyschleniki" from Siberia, and maintained Russia's interest in her North American empire for a century and a quarter, has declined to insignificant proportions.

Yet should you ask the man on the street to list the two main export products from Alaska, the chances are he will reply "gold and furs." Even along the Pacific Coast where the products of Alaska enter continental United States, very few realize that the gold and fur days have long since passed, and that canned salmon and other products of the sea, have for years constituted 65 per cent or better of the wealth coming from our northland territory (Figure 1).

The Total Commerce of Alaska

The total commerce (exports and imports) of Alaska during the 22 years from 1916 to 1937 has averaged annually slightly under $100,000,000. The general trend during that time, however, has been somewhat downward. During the war years of 1916 to 1918 Alaska reached the greatest heights ever recorded in the history of the territory, with an average over the three years of some $130,000,000 per year.

Following the war the total commerce slumped greatly, in response to the short but definite depression of 1921. Recovery was rapid, however, and by 1923 close to $100,000,000 worth of commerce was passing Alaska's ports once more. Then came the so-called prosperous years, 1926 to 1929, with an annual average well above the $100,000,000 mark. In 1929 there was a slight letdown due chiefly to lowered values in copper and fish. In 1930 and 1931 the effects of the world-wide depression began to be felt. Alaska was slow to respond to the depression, and even as late as 1931 the total trade was not within $10,000,000 of the low point reached in 1921. Nineteen thirty-two was the real depression year for Alaska. That year the total commerce scarcely exceeded $60,000,000.

Since 1932 Alaska has been on the upswing again, 1937 indicating nearly $115,000,000 passing in and out of the territory's ports, the biggest business since 1918.

From a region of rather intensive exploitation it is to be expected that the total exports would be mainly responsible for the pattern taken by the curve of total commerce. The average annual exports since 1916 have amounted to approximately $59,000,000, or nearly twice the total imports. This would seem to indicate an exceptionally high balance of trade in favor of Alaska. As a matter of fact, from 1916 to 1937 this trade balance averaged annually about as much as the total imports. With a positive trade balance of nearly $33,000,000 a year, a mercantilist economist might be led to conclude that Alaska is a wealthy territory, amassing vast treasure.

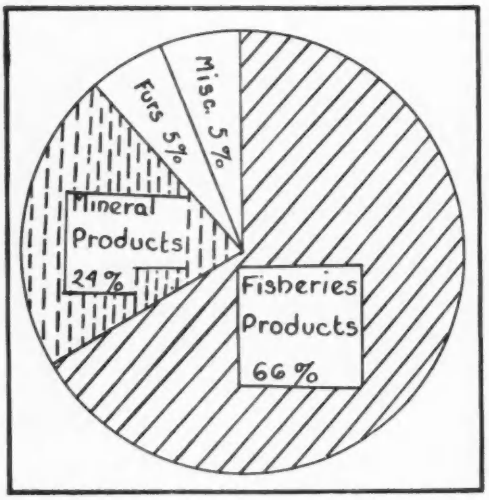

FIGURE 1.—Average of Alaskan exports for the decade 1927–36.

However, very little of that balance adds to the economic well-being of the Territory. In the first place it depends primarily upon the extent of the fish runs, and the prices on fish and copper. Most of the mines and canneries are owned by a few large corporations that raise their capital and distribute their earnings to outside stockholders, most of whom never see Alaska.

Even the trade figures on total imports do not necessarily reflect the well-being of the citizens of Alaska. It is true that imports increase during good times and decline during bad times, but a large percentage of the total import is made up of producers' goods—canning supplies, fishing gear, mining equipment, and the like. The citizens of Alaska get their share only in the form of wages and commissions, and the Territory collects only a small share in the form of taxes, licences, and fees.

THE PRODUCTS OF THE FISHERIES INDUSTRIES

The total value of fish products from 1919 to 1936 averaged somewhat over $38,000,000 per year, representing by far the largest single item in the export trade of Alaska. Between 65 and 70 per cent of the total export is composed of the products of the sea. A chart showing the total export curve and the total value of fish products shows a surprisingly high correlation (Figure 2).

The value of fishery products has held up well even during the depression and resultant low prices for canned salmon of all grades. Dropping from a war-time peak, the 1921 depression year cut the total value of the fisheries to around $23,000,000. In 1932 the total was $25,478,000, still nearly $2,500,000 more than 1921. In between these slump years there were several normal years and several years of greatly augmented production, during which time capital was easy to get, resulting in over-expansion of the industry with consequent over-production when two years of unusually large salmon runs occurred. These factors helped create the low prices of the past few years and made the depression in the market all the more noticeable.

However, since 1932 the Alaska fisheries have more than regained their normal importance. In 1936 the output of canned salmon reached a new level, the total pack amounting to 8,437,603 cases, valued at $44,751,633, nearly a million cases in excess of the previous record pack in 1934. As a usual thing salmon products represent from 88 to 92 per cent of the total value of the Alaska fisheries.

In spite of the extensive utilization of the salmon resources for commercial purposes, the 1937 annual report of the Governor of Alaska states that these recent large runs show conclusively that governmental efforts to preserve the salmon supply in Alaska have been successful and that the question of perpetuation of the Alaska salmon supply has been solved.

PRODUCTION OF THE MINERAL INDUSTRIES

The mineral output from Alaska shows the most definite ups and downs of any of the extractive industries. Mineral exports began to play a dominant part, not with the Klondike discoveries of 1898, but rather with the Nome developments after 1905. Since 1880 to the end of 1936 the total mineral production has been $722,222,000 of which more than 65 per cent was furnished by the gold lodes and placers and about 30 per cent by copper lodes. It may be remembered that the original purchase price of Alaska was only $7,200,000 in 1867, and that prior to that time the Russian-American Company conducted costly explorations for minerals and officially announced that none existed in paying quantities.

It is significant that the copper developments were just getting under way for efficient production about the time of the beginning of the war in Europe. Hence the peak of the mining industry coincided with the war years. Nearly $50,000,000 worth of minerals were shipped from Alaska in 1916. Since 1917 there has been a steady decline. At the present time minerals make up but little over 20 per cent of the total exports of Alaska. It is entirely possible that the output curve for minerals will never again rise to any appreciable degree. Undoubtedly there are mineral resources that have never been found in the Territory. Certain it is that Alaska is somewhat concerned over the decline of the produce of the mines, and voluntary and subsidized prospectors, as well as members of the United States Geological Survey are continually searching for new discoveries.

Since 1919 the total mineral output has averaged annually close to $14,000,000, but the average for the five-year period ending in 1932 was some $13,500,000. The 1932 output was only $11,638,000 since which year a rather interesting increase has taken place. In 1936 the highest mineral output since 1918 was recorded.

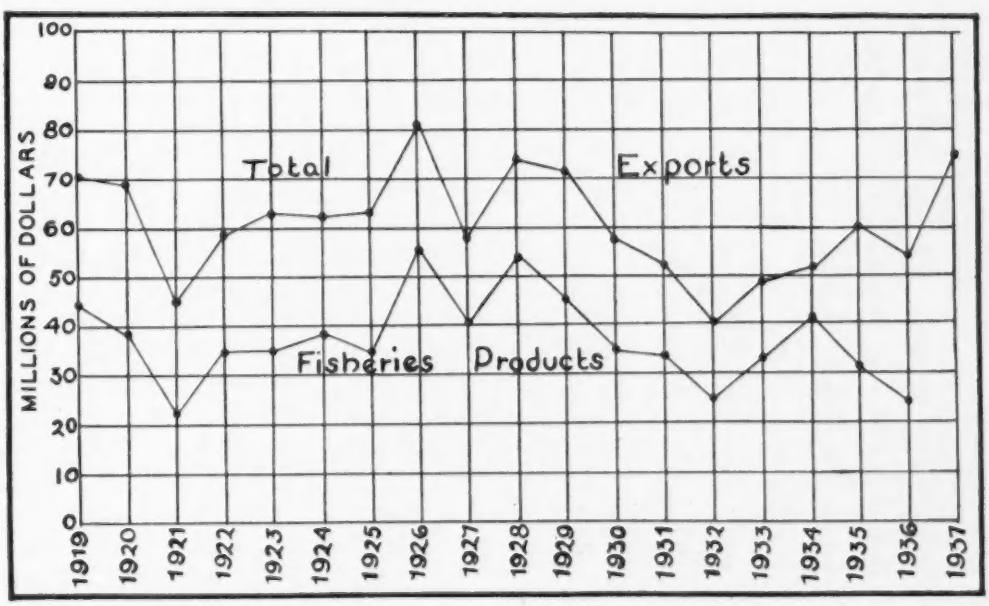

FIGURE 2.—Dependence of the total export upon the fisheries products in Alaska reveals itself in the close correspondence of the two curves in this graph.

From the early years of the war until 1929 copper was the most important mineral produced, running twice the value of gold and silver mined during those years. The decline in demand after 1923 caused a rapid drop in output and when the price of copper hit its all-time low in 1930, the exports fell off tremendously. Except as ballast, copper ore could not pay the cost of mining and transporting when refined copper was selling for five or six cents a pound. In 1931 slightly over $2,000,000 worth of copper was exported from Alaska, whereas from 1919 to 1923 the average annual production was around $12,000,000. In 1932 only $550,000 worth was produced. But this was not the end. The following year the large Kennecott mines closed down and only $1,900 worth of copper found its way on the records. In 1935 with a firmer market price over one million dollars worth was shipped and in 1936 $3,720,000 in valuation indicated the extent of the copper come-back. The resources are plentiful; the output must depend upon the economics of the market (Figure 3).

Since 1919 gold production declined for some nine years and then started up once more. The decline from 1920 to 1928 was due chiefly to the period of prosperity and prevailing high prices, with the relatively low purchasing power of gold that prevailed during most of that time.

In the past few years the amount of gold produced by prospectors working low pay placers during depression times when other industries were slack and when the purchasing power of gold was relatively high, has increased to a considerable extent. The gold production curve rises inversely with the general economic conditions of the outside. The recent rise in price of gold has sent an army of prospectors into the northland. A gold rush, likened almost to Klondike days was under way during the spring and early summer months of 1934, but the sudden jump in value from $9,000,000 in 1933 to $16,000,000 in 1934 was due largely to the new price of gold.

This high gold valuation, plus a slight comeback in copper and increased activity in tin and platinum, account for the highest production of minerals in 1936 since war years nearly a quarter of a century ago. The 1936 total mineral valuation reached $23,594,000.

THE FUR SITUATION

The wealth from furs and pelts taken from both marine and land fauna, and which for a century and a quarter constituted nearly 100 per cent of the export wealth of Alaska, today amounts to only 5 per cent of the exports.

Since 1919 the values of furs have risen slightly and the industry shows signs of coming back to a sound basis. During these years the average annual production has amounted to about $3,000,000. The years 1928 and 1929 were the highest, the latter representing over $5,200,000. The last several years have shown a slump to something under $2,000,000. There are two reasons for this condition in Alaska's fur trade: first may be mentioned the decline in fur price; second, the withholding of many pelts and the curtailment of killing of blue and silver foxes, most of which are island or pen-raised, under domesticated or semi-domesticated conditions.

Sealskins have shown a steady increase since the federal government took charge of the Pribilof Island rookeries in 1910. Being a non-competitive industry the government takes every year just the number consistent with a perpetuation policy. The muskrat exports present an interesting situation. Both the number taken and the values show steady increases since 1927. Right

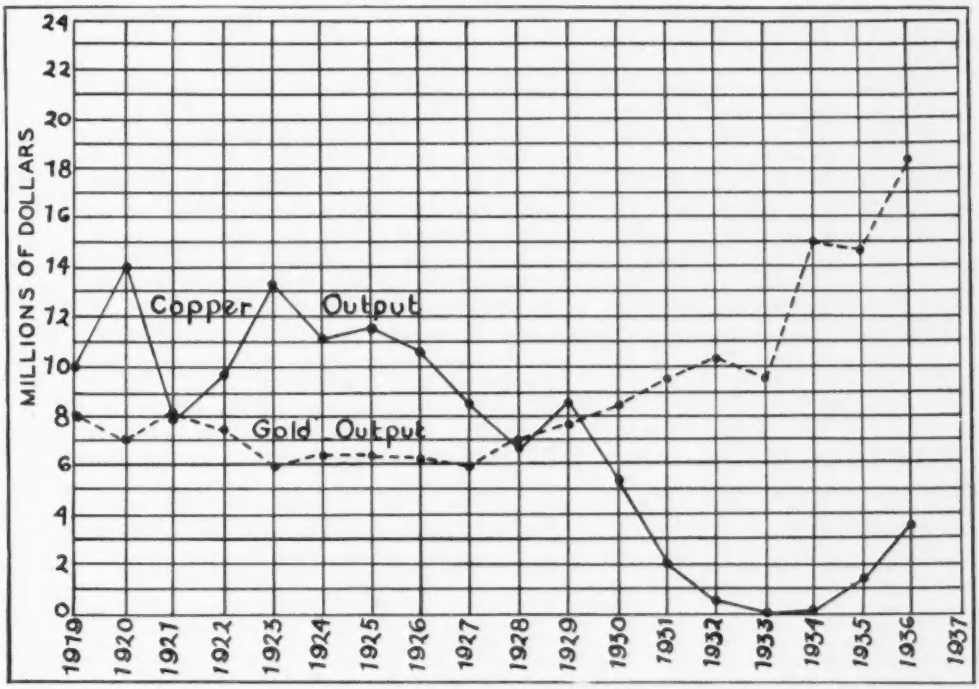

FIGURE 3.—The relative position from year to year of the outputs of copper and gold changes significantly, chiefly in response to the world's demands for these metals and the prices which they bring in the world's markets.

through the depression years the figures have risen. There are at least two reasons for this situation. More and more muskrats are being raised under protected and semi-domesticated conditions, accounting for a large increase in the animals. And during times of depression more and more demand arises for a cheap fur which is fairly durable and which through processing can be made to look like a far more expensive product.

REINDEER MEAT

Among the miscellaneous exports reindeer meat seems to be the most important. Reindeer were introduced into Alaska from Siberia in 1891 as a relief measure to provide food and clothing for the natives. The original herd contained less than 1,500 head. From this small herd the entire western part of Alaska has been stocked and it is estimated that there are more than 500,000 animals in the herds today.

Up until 1920 nearly all of the surplus from the herds was used to supply the natives, but since then there has been a growing export. The average annual value shipped over the past five years has amounted to something over $116,000. The peak of exports to date was reached in 1930 when 1,566,485 pounds of meat were shipped valued at $157,918. In 1931 the value dropped to $106,298, but the poundage remained fairly high. In 1932 the low prices of 1931 had a discouraging effect and the total production dropped to 246,927 pounds, valued at $24,693. It has been demonstrated that this industry has great potentialities. Most of the export is utilized in the manufacture of high grade cat and dog foods, a market which has been rising rapidly since the depression.

THE CHARACTER OF ALASKAN IMPORTS

It is interesting to examine a few of the leading commodities entering into the import trade of Alaska. Consumers' goods are mostly foodstuffs, clothing, and supplies of a rather direct subsistence nature. The greatest values in imports lie in the producers' goods that center around the fishing and mining industries. Following is a list of ten of the most valuable imports in order of rank, tabulation from June 30, 1930 to June 30, 1931:

1.	Tin cans, finished or unfinished	$3,889,585
2.	Gasoline and naphtha	717,926
3.	Fish cannery equipment	548,552
4.	Butter	525,655
5.	Beef and Veal, fresh	514,737
6.	Mining and quarry machinery	474,441
7.	Eggs	462,392
8.	Cotton wearing apparel	444,267
9.	Tin plate	409,141
10.	Milk, condensed	388,827

Well over $200,000 worth each of hams and bacon, $327,000 worth of canned vegetables, $228,743 worth of canned and prepared fruits, $306,013 worth of coffee, $331,871 worth of refined sugar, and $149,985 worth of smoking tobacco may also be listed among the typical imports.

Further in the clothing line are found some 50,892 pairs of leather boots and shoes imported and 55,631 pairs of rubber boots. (Total population in 1930 listed as 59,278.) Among a few miscellaneous imports may be listed $288,844 worth of lubricating oil, $208,975 worth of wire most of which is used in the construction of fish traps or in the building of fox, mink, or martin pens, $305,173 worth of dynamite for the mines, and $185,069 worth of arms and ammunition.

If one knew nothing else about Alaska except the character of the imports he could easily tell that the Territory is a pioneer region in a highly exploitive stage of development, with scarcely a start toward economic self-sufficiency.

CHANGING FRONTIER IN THE COLUMBIA BASIN

Albert L. Seeman and Harold E. Tennant

THE westward migration of American people has long been a topic for historian and geographer. Both, in general, have assumed in their many discussions that the westward migration ceased about three decades ago and with cessation brought a permanent change in man's occupation and viewpoint, economically, politically, and socially, because he could no longer "go west" if conditions proved unsatisfactory in his home area. In all of these westward migrations rivers were focal points. These foci varied with the period; first the Ohio River became the destination, later the Mississippi, Missouri, Columbia and many other streams and tributaries. The Federal Government through the application of the Reclamation Act has in recent years fostered migration and created an artificial frontier. Again, the foci are rivers of western United States. The largest of these artificial frontiers is being brought into prominence on the Upper Columbia Basin by the construction of the Coulee Dam (Figure 1).

History of Adjustments

The first attempt at agriculture in the area lying west of the Rocky Mountains and north of San Francisco Bay was at Colville, Washington, in 1826. It was at Colville some years later that gold was discovered; this caused the first extensive immigration into the Upper Columbia Basin, or the Inland Empire. Men with pack trains came into the region from Canada, California, and east of the Rocky Mountains just as they had gone to the Fraser River and to California a few years before. Many of these mining camps developed rapidly into towns; oftentimes their disappearance was just as rapid.

Paralleling the development of the mining towns there grew the outfitting and distributing centers for these mining communities. Trails radiated in all directions from these outfitting towns and long lines of horses and mules carried goods over the divaricating trails. These towns became the winter quarters for the miners and their horses and mules. Much of the food and feed demanded in these outfitting and distributing centers was necessarily shipped in from other regions; the resulting high prices were sufficient incentive to inaugurate the home production of many commodities. The high prices, furthermore, encouraged many people to migrate to the region to engage in agriculture and stock raising. Soon the mining population diminished, both actually and proportionately, while the herder and farmer continued their migration into every valley and plain. The Yakima Valley and Walla Walla Valley were first colonized; they were settled in 1839.

By 1870 the marketable produce from the Inland Empire was already greater than the local demand. The people needed better transportation than the uncanalized river provided. The populace of this entire region was waiting for a materialization of the promised railroads to give them a larger market for their surplus production. The Inland Empire is, thus, the last region in the United States to prove that the area which can grow wheat will become a farming region. Once the migration of farmers into the Inland Empire had started, immigration continued steadily.

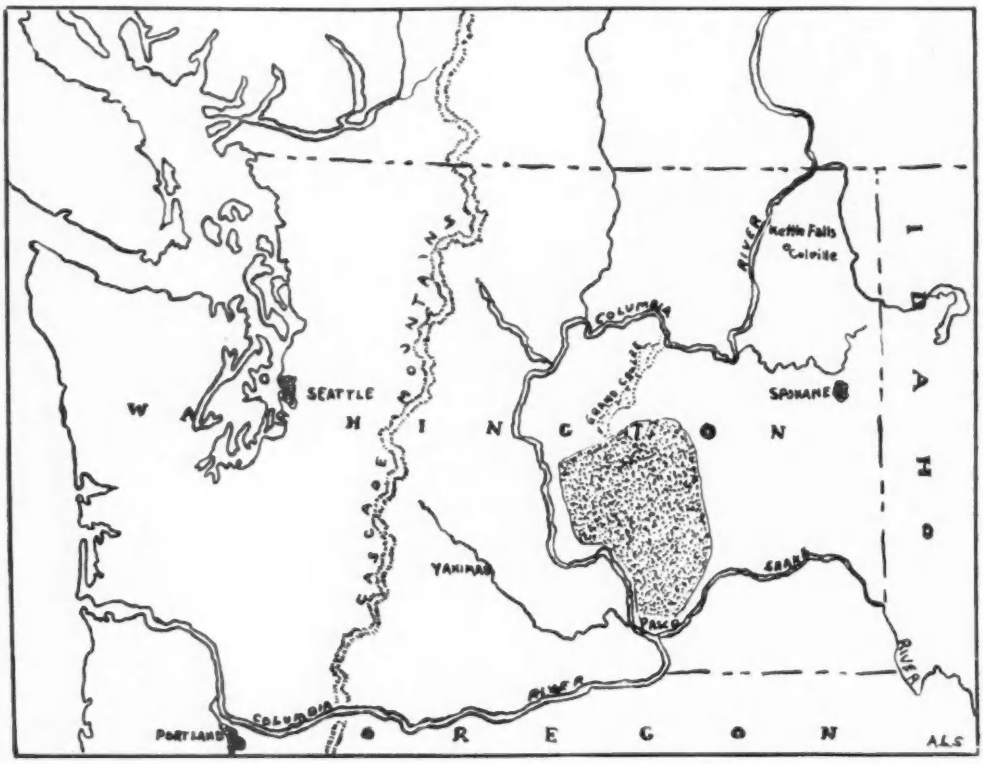

FIGURE 1.—Columbia River Basin, showing proposed irrigation project.

Cheap lands, rich soil, and the extension of the railroads brought an increasing number of acres into production. In fact, the spread of wheat growing throughout the Inland Empire has been closely connected with the history of transportation of that region. It was not until better means of transportation had been established that large scale production was practiced. The various transcontinental railroads had scarcely completed their main lines before each road was projecting branch lines into the other railroad's territory. The struggle of these railroads for traffic not only populated the whole territory, but it also brought about a tremendous production of wheat.

The result of all of this has been to make the Inland Empire one of the principal wheat-producing areas of the United States.

The first orchards in the Inland Empire came into existence from seeds planted by the Jesuit missionaries in connection with their other activities. The early orchards were planted in the Okanogan Valley and at Kettle Falls in Stevens County, Washington. The seeds had been carried from eastern United States and in some cases directly from Europe. The first fruit tree grown on the banks of the Columbia River sprang from seed of an apple eaten at a dinner in London, England. The dinner had been given for Captain Simpson. Apples were served for dessert and the seeds placed in Captain Simpson's pocket. Upon his arrival at Fort Vancouver in 1827, he discovered the forgotten seeds, and gave them to the gardener to plant.

Many orchards were planted by the early settlers to satisfy the immediate

needs of their families. No attempt was made at first to grow fruit on a commercial basis and it has been only within the last quarter of a century that the raising of horticultural products has been commercialized.

What has just been said of fruit growing is characteristic of vegetables and small-fruit production. Prior to 1900 vegetable growing was on a small garden basis; since that date the industry has developed rapidly. The shift from extensive farming to intensive production, including horticultural commodities, was necessitated by increased costs, i.e., from dry farming to irrigation farming. This shift in the type of farming was necessitated by an increased density of population and the resulting higher costs of land.

The two decades from about 1870 to approximately 1890 was the heyday of open stock raising in the Inland Empire. On this vast plateau the stock men located their claims near some sheltered valley. These valleys usually had some alluvial soil and a water supply for irrigation; grain and vegetables could be grown for home consumption. The herds cared for themselves, multiplied, and made their owners wealthy. There was no restriction on the size of the herds since pasturage was unlimited during these two decades and it was free. However, restrictions began to be felt when the public lands were taken up; by gradual stages the old type of ranching was forced to give place to a system of enclosed ranges.

COULEE DAM

Actual work in the construction of the gigantic Coulee Dam was started in the fall of 1933. In order to get appropriations from Congress the original bill provided for the construction of a dam for hydroelectric purposes. The irrigation clause was, originally, minimized in order not to antagonize eastern congressmen. However, in the minds of the sponsors, irrigation was a very vital part of that bill and was not brought to the fore until after the original appropriation was made. In the construction of Coulee Dam many records have been broken by the United States Reclamation Bureau. These records include the largest cofferdam in the world, pouring 16,000 cubic yards of cement per day, excavating 18,000,000

FIGURE 2.—View of the Columbia River in 1930 before work was started on the construction of the dam. (Courtesy U. S. Bureau of Reclamation.)

cubic yards of material, using about 32 per cent more cement than in the construction of Boulder Dam, the preparation to irrigate 1,200,000 acres of land, together with many other records. The irrigating of this vast tract of land will bring many and complete changes in the adjustments of the Upper Columbia Basin.

PROBLEMS ARISING FROM POTENTIAL ADJUSTMENTS

The potential adjustment of any region necessarily implies a wholesome respect for the existing occupations. The foregoing discussion has indicated the adaptations which have been possible up to the present time in the Columbia Basin area. The dual development of the Columbia Basin Project as a whole involves water for irrigation and generation of electric power. With the application of water to the lands of the Columbia Basin, certain problems will have to be solved and changes in the present adjustment will take place. The chief problems include: (1) land speculation, (2) repayment costs to the Government, (3) over-development, and (4) markets.

FIGURE 3.—Columbia River, taken in 1935 about one year after work had started. At the left can be seen the dry river bed for the construction of the cofferdam.

Land Speculation. Since the feasibility of the project depends, in part, upon the settler obtaining his land at its actual land value, Congress in May, 1937, passed the Anti-Speculation Act. The law requires the Secretary of Interior to obtain an impartial appraisal of all the project lands at their present day value without any reference to the probable availability of irrigation water in the future. Any land which is to receive water, under this law, either must be sold at this appraised value of dry land or its owner must pay a penalty ranging from half to the entire amount paid in excess of the appraisal, otherwise water will be withheld.

Thus are gone the days when construction of a Federal irrigation project was the signal for the start of a land boom. Speculation in project land is injurious to the settler who honestly desires to make a home for himself on a new irrigated tract as well as to the Government, which is required by law to collect from the settlers over a period of years the cost of the reclamation projects. The settler who buys raw land at speculator's prices, usually finds himself unable to subjugate the land, to build his lateral canals, and plant his first crop. This means failure for the settler and, in turn, failure for the project.

Repayment Costs to the Government. Two sources of revenue are possible for the Government in the repayment costs for development of the Columbia Basin Project: (1) the taxing power of the irrigation districts to be formed, and (2) revenues from the sale of continuous firm power to be generated at the Grand Coulee Dam. It has been estimated by the engineers of the United States Bureau of Reclamation that the secondary power will meet the requirements for irrigation, pumping, and standby service.

Repayment revenues from the taxable power of the irrigation districts in the Columbia Basin will be derived in response to the demand for lands by settlers, the rapidity with which the units of land may be brought under irrigation and cultivation, and the returns realized by settlers as a result of successful production and marketing of commodities.

Over-development. Lands brought under irrigation faster than they are required by settlers represent idle investments with no income from economic utilization. At the same time irrigated areas settled and put under production in excess of market demands are also economically unsound. Such a problem in the Columbia Basin area can be met only through a consistent policy of long-range planning, bringing in units of 20,000 to 50,000 acres per year or even over longer periods as conditions may justify. This was the program successfully applied by the United States Bureau of Reclamation in the irrigated valleys of Wenatchee and Yakima in the State of Washington.

Markets. This problem must be considered both from the standpoint of distant and home markets. Competition with the Midwestern and Eastern markets in agricultural commodities is a matter for serious thought. Corn, cotton, wheat, tobacco, potatoes, and apples are the crops which normally offer troublesome national surpluses. Data compiled by the United States Bureau of Reclamation indicates that the products from irrigated projects entering channels of trade and competing in national markets represent only 5 per cent of the total. Of this 5 per cent only a small fraction is represented by the commodities of corn, cotton, wheat, or tobacco. The apple surplus is more apparent than real, since the national production of apples has been steadily declining for forty years. As to potatoes, the area planted to this crop fluctuates widely from year to year. It is a bulky, perishable crop and should be restricted in production on irrigated projects so as to supply only

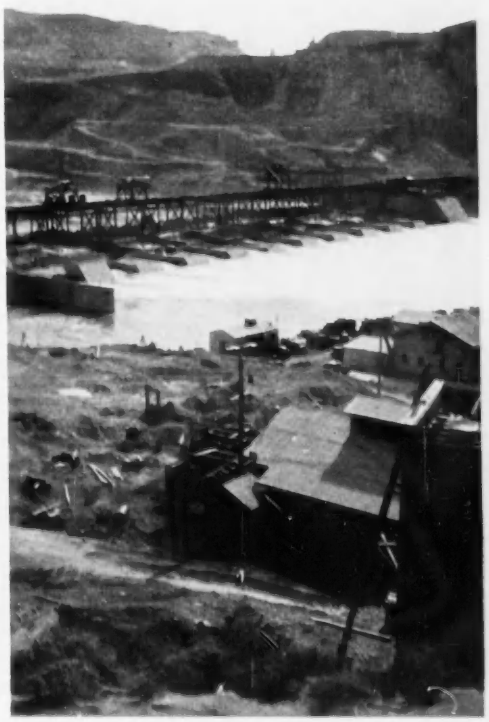

FIGURE 4.—The completed low dam. Photograph taken in 1938 and just before work was started on the high dam.

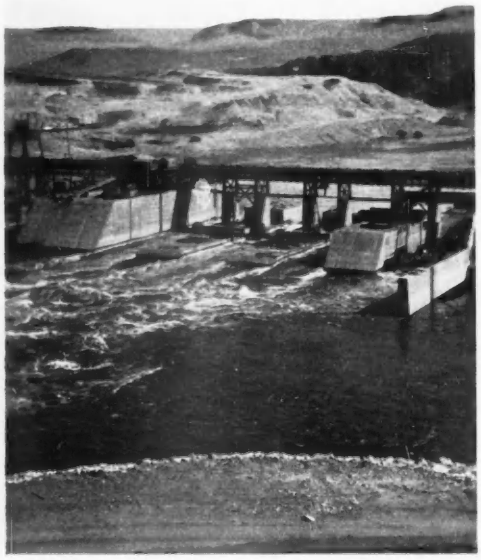

FIGURE 5.—Close-up view of Figure 4 of part of the low dam. The railroad tracks used to pour the cement are still in place.

definite local market areas. Potato acreage could readily be absorbed by other crops to which the irrigated areas are especially adapted. In addition, the factor of transportation rates to distant markets on products from the Columbia Basin of low value and great bulk should act as a deterrent against competition with Midwestern and Eastern agriculture, and accordingly, only products of high quality and of comparatively high value—specialty products—which cannot be produced seasonally or at low cost in the Eastern humid areas, can surmount this distance hurdle.

FUTURE ADJUSTMENTS

In the long-range program of bringing 20,000- to 50,000-acre units of land under irrigation, such units would be broken up into smaller tracts of from 20 to 160 acres; those not larger than 20 acres have been designated as "Maintenance Tracts." The purpose of the "Maintenance Tract" would be to provide permanent livelihood and homes for farmers from marginal lands or for settlers desiring to establish homes on irrigated lands for other reasons. For the purpose of this discussion the 20-acre "Maintenance Tract" will be used as a basis. It may be expanded proportionately to apply to the 40-, 60-, 80-, or 160-acre tracts, as the case might be. Production on the 20-acre "Maintenance Tracts" would be confined to diversified crops which could be largely consumed by the families themselves.

The records of the United States Bureau of Reclamation indicate that each family on a farm will maintain a like-sized family in town and it is, therefore, possible to work out a balanced production on each 20 acres, which would allow the farmer to sell half of his produce to maintain the family in town and thereby give him cash with which to buy clothing, pay for electricity, and other living costs. Likewise, the urban business man, artisan or industrialist could in turn produce enough of his goods to maintain his family and his surplus could be largely absorbed by the demands of the farmer.

The "Maintenance Tract" purchaser would be furnished profitable employment on the construction of the irrigation system. The work week would consist of five six-hour days and the salary would be $15 per week. This is on the basis of 50 cents per hour. The Government would pay one-half of the worker's wage ($7.50) in cash each week, to enable the family to meet its living expenses while purchasing the land, building a home and preparing the "Maintenance Tract" for irrigation and cultivation. The other half of the wage would be applied by the Government against the purchase price of the land and the loan made for its improvement,

and the Government would hold the mortgage on the tract. This weekly work plan would allow the purchaser sufficient time outside of work to improve his land—clearing, fencing, building construction, and in general preparing the "Maintenance Tract" for irrigation.

Each purchaser would have ten years in which to complete his home and get his land ready for cultivation when the water for irrigation is available. During this period, the Government would advance up to $2,500 in all, to include cost of tract, original loan for building material, loan for purchase of stock and installation of electric equipment. Preparation would be made for complete electrification of the farm when the power and water lines are ready. This amount will be advanced in installments as the improvements of the tract progresses. Of the total sum of $2,500 advanced, from $300 to $1,000 would be for materials necessary for home construction.

At the end of the ten-year period, the purchaser has paid in $3,900; the amount is withheld by the Government from wages for labor expended on the irrigation project over the ten-year period—the worker receives $15 per week, and of that sum one-half is retained by the Government, or $390 per year and $3,900 for the ten-year period. Thus the Government has received back the $2,500 advanced for land and installation of complete equipment for electrified farm, plus $1,400 to apply on purchase of water right. This water right should not exceed $100 per acre, or $2,000, leaving only $600 remaining to free the land of all encumbrances.

Based on production figures for irrigated farms in eastern Washington, a twenty-acre tract will support a family of five. The arrangement in Figure 7 has been suggested by the United States Bureau of Reclamation for a "Twenty-Acre Maintenance" tract.

According to estimates furnished by the United States Department of Agri-

FIGURE 6.—Drawing of an artist's concept of the completed high dam, power plants, and permanent government town. (Courtesy U. S. Bureau of Reclamation.)

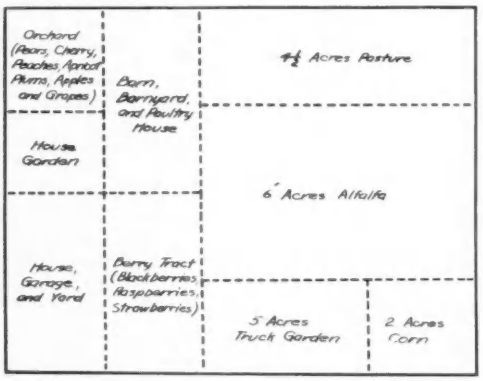
Orchard (Pears, Cherry, Peaches, Apricot Plums, Apples and Grapes)
Barn, Barnyard, and Poultry House
4½ Acres Pasture
House Garden
6 Acres Alfalfa
House, Garage, and Yard
Berry Tract (Blackberries, Raspberries, Strawberries)
5 Acres Truck Garden
2 Acres Corn

FIGURE 7.—Layout sketch of "twenty-acre maintenance" tract.

culture to the United States Bureau of Reclamation, it would be possible to receive the following returns from stock and produce on a "Twenty-Acre Maintenance Tract." These figures are cited merely as a guide and would, of course, vary with price fluctuations in markets as well as with other factors which could not be controlled or anticipated:

Value of Products Used in Home		
1 calf	$ 10.00	
4 hogs	40.00	
365 dozen eggs	73.00	
120 pounds poultry meat	30.00	
Lambs	25.00	
Hay (19 tons)	190.00	
Fruit and vegetables	100.00	
Total		$ 468.00
Income from Sale of Farm Products Over and Above Home Consumption		
3 calves @ $10.00	$ 30.00	
365 lbs. butterfat @ 25¢	91.00	
4 200-lb. hogs @ $10.00	40.00	
365 dozen eggs @ 20¢	73.00	
5 lambs @ $5.00	25.00	
10 sheep (wool) @ $2.00	20.00	
17 tons of hay @ $10.00	170.00	
Fruit and vegetables, 6A, @ $50.00	300.00	
Total		749.00
Total income from the farm		$1,217.00
Expense of power and taxes	$250.00	
Expense of irrigation	40.00	
Total	$290.00	
Net cash income ($749.00 minus $290.00)		$ 459.00

Specialty Crops. With the growing season characterized by long, bright sunny days, with temperatures reaching 100 degrees Fahrenheit in summer and with adequate moisture furnished by irrigation, the Columbia Basin is admirably adapted to the growing of alfalfa, vegetables, sugar beets, hops, potatoes, berries, grapes, soft fruits, orchard fruits and Jerusalem artichokes. The variety of these crops, together with the fact that they are products non-competitive with Midwestern agriculture, should be an incentive to the "Maintenance Tract" farmer in the Columbia Basin who has reached the point where he is able and desirous of extending his operations to 40, 60, 80, or 160 acres with the object in view of increasing his cash income.

Industrial Crops and Processing. Constant chemical experimentation is making possible increased use of agricultural and forestal products in industry. Through the studies and investigations of the Farm Chemurgis Council, it is estimated that the industrial demand for farm products will eventually exceed the human demand. According to this organization "50,000,000 acres of farm land could immediately be used for making industrial products," which would include such crops as soy beans, vegetable fibres, alcohol grains and tubers, and tannin plants. Growing conditions in the Columbia Basin are admirable for any of these products with the aid of irrigation.

Linked with the growing of these industrial crops is the processing of finished manufacturing of them. Power from the Coulee Dam would be available for the processing of such products for industrial use and the plants could be owned and operated by a group of farmers; the plant would be supervised by an expert trained in the chemical process or the mechanical process, as the case might be. From one-half to two-thirds of the crops raised in the Columbia Basin region could be used in industry for which they will be raw material.

Forage Crops. The Western ranges are producing 55 per cent of our sheep and lambs, 33 per cent of the cattle and calves, 75 per cent of the nation's wool and mohair. In the West are produced the unfinished lambs and unfinished cattle for the Middle Western farmer to fatten for market. The live-stock business of the West is complementary to, and not competitive with, the Middle West. Cattle and sheep, summered on rugged grazing areas, are moved to fertile lower lands for wintering. Except for irrigated land the ranges in the eleven Western states would have only a limited use. In nearly all of these states there is a demand for irrigation of additional lands solely for the production of winter feed for herds and flocks. The reclaimed areas of the Columbia Basin would be a valuable addition to such lands.

CONCLUSION

The future adjustment in the Columbia Basin region will be primarily agricultural, including subsistence, commercial and industrial types of crops. Continued chemical experimentation and cheap power rates may favor processing industries as another adjustment, with some finished commodities being fabricated in special lines. Power generated at the Grand Coulee Dam will be transmitted to the Basin region and sold at reasonable rates for commercial, agricultural and domestic purposes, while unusually good transportation facilities bring the region within the proximity of extensive markets. To preclude uneconomic development, the units of irrigated land should be brought into production only as conditions warrant.

BOOK REVIEWS

PARAIN, CHARLES. *La Méditérranée, Les Hommes et Leurs Travaux*. 209 pp. Published by Librairie Gallimard, Paris, 1936.

Professor Alfred Philippson in his great work "Das Mittelmeergebiet" develops his main thesis in a most scholarly manner. He drives home succinctly, yet convincingly, the importance of the Mediterranean Region to man in his gradual advance toward our modern complex civilization, pointing out how necessary Greece and Latium were as intermediate steps between the desert oases of Arabia and North Africa and the densely populated industrial areas of Northwestern Europe. Many books have been written on the Mediterranean since the publication of this classic, but none has given a better picture of the region as a unit.

Charles Parain in his new work especially emphasizes "human" geography. This is a study of the Mediterranean Region, but the sub-title, "of the men and their works," gives a clue to his approach. In so-called "human" geography human beings are sometimes treated as secondary factors, envisaged as almost totally dependent on the whims of a capricious Nature, rather than as the active agents they have so often shown themselves to be. In this volume less attention is paid to urban or even to maritime life—although the latter is adequately treated in Chapters IV and V—than to agricultural activities, for the very good reason that Mediterranean civilizations were, are, and will be based upon agriculture. Even many huge agglomerations, almost urban in character, are inhabited by peasants. This agriculture is of a special type, characterized by arboriculture and a perpetual battle with drought. Chapter VII gives an historical account of the development of agricultural practices. Methods similar to those employed in modern *dry farming* were mentioned by Homer, Xenophon, Theophrastus, and Vergil. The immense amount of hand labor required, especially when cereals were the main crop, practically made slavery or serfdom necessary. Moreover, it is pointed out that more land was originally held by village communities than is generally supposed.

Large landholdings are an important factor in the Mediterranean Region. Sometimes they are of feudal origin; others have resulted from the encroachment of great landlords upon either small individual or large communal holdings; still others are huge grants awarded to some successful military leader. In the Balkans the victorious Turkish chieftains appropriated great blocks of land, or "tchifliks," often merely ousting Christian landlords. In Syria large estates are the rule, especially in the cereal country east of the coast ranges. In Algeria after the French conquest huge concessions were made to companies and individuals, particularly during the Second Empire. Great landholdings, or "latifundios," are quite widespread in southern Spain, while in Sicily 1400 estates comprise 30 per cent of the total area. Great holdings are prevalent in Italy, both in the Po Valley where intensive agriculture obtains, and in extensively farmed regions of the south. Even in the French Midi large estates (over 10 hectares) are becoming general, taking up from 35 per cent of the cultivated land in the Pyrénées-Oriental to 50 per cent in l'Aude. The problems of the wine-producers in this region are treated (pp. 141–143) at length by Jules Sion in "La France Méditerranéenne" (Librairie Armand Colin, Paris, 1934). Unfortunately, great landholders are not, as a rule, convinced that *noblesse oblige*. Their estates are simply rented out by the resident manager, and the owners being assured of ample income without risk and without effort, they make no attempt to increase production and thereby raise the standard of living of the miserable peasant. This has been true from one end of the Mediterranean to the other. It is easy to blame the climate or the "Latin temperament" for the growth of brigandage, the vendetta or the maffia, depending on the region, instead of unemployment, very low wages, and the consequent miserable living conditions for which bad harvests and the greediness of usurers have been largely responsible.

However, centuries of experience have taught the Mediterranean peoples that landholdings below a certain size are not stable in regions where harvests are likely to be uncertain because of droughts. By the fourth century B.C., in the city-state of Athens, small landholdings were gradually acquired by rich money lenders till large holdings were the rule. The history of European colonization in North Africa has conclusively proved that in those areas best adapted to the extensive production of cereals only large-scale holdings can survive. It is easy to draw parallels between such areas and our great wheat-producing states. North Africa might well be an object lesson to those who look with misgivings upon the development of vast machine-cultivated landholdings in the Wheat Belt. The rainfall, at all events, can with impunity be independent of political systems, so, although 160 acres may support a family—or even two—in the Corn Belt, the same is not true in the Wheat Belt,—no matter how much wishful thinking is done.

The soil and climate made it possible for Athens, Carthage, and Rome to accumulate great wealth, found empires, and in so doing to acquire

slaves in large numbers. The utilization of this seemingly limitless labor supply speeded up remarkably the evolution of the civilizations of antiquity: it made possible a leisure class that could devote all its time to creative work in the arts or to abstract thinking. "The system of slavery formed the material basis of a flourishing cultural development, before precipitating the ancient world into definite ruin. In speaking of Mediterranean civilizations it is necessary to distinguish, on the one hand, that which constitutes for them a durable, ever-valid basis from that which, on the other hand, has not been, in the history of human societies, but a unique and transitory success, the glamour of which should not mask the inherent defect." Page 209.

Philippson, a competent geologist as well as a geographer, in his exhaustive study of Apulia ("*Apulien*" Overgedrukt uit: Tijdschrift van het Koninklijk Nederlandsch Aardrijkskundig Genootschap Deel Liv, I—Januari, 1937. Pages 34–87) subdivides the province into geological regions and then interprets them from the point of view of the geographer. Here again great landed estates prevail, on which most of the work is done by day laborers. Agriculture has the characteristics of an industrial undertaking for two reasons: (1) The amount of precipitation varies greatly from year to year, causing great fluctuations in total annual yields. Large estates can survive such conditions better than small holdings. (2) The agricultural products are mainly for export, hence subject to the vagaries of foreign markets. Here again the margin of safety is not great enough for the small peasant.

Professor Philippson's monumental work, his "Grieckische Landschaften" in three volumes, is nearing completion.

RAYMOND E. CRIST

ANTEVS, ERNST. *Rainfall and Tree Growth in the Great Basin, 1938.* 97 pages. Published jointly by the Carnegie Institute of Washington and the American Geographical Society, Baltimore, 1938.

Dr. Antevs first presents the data of precipitation, run-off, lake levels, and related phenomena for each of five regions in northeastern California, south-central Oregon, northern Nevada, and northern Utah, comprising the northerly portion of the Great Basin, using all sources of possible information to supplement actual measurements of precipitation and run-off data, and determine as accurately as possible the conditions in the years preceding instrumental records. He then compares the data for these regions and discusses the main rainfall fluctuations and their significance. In succeeding chapters he discusses factors of tree growth and details of studies he made of tree rings at Susanville, California, and Lakeview, Oregon, in 1931, correlating these data with the records of precipitation, run-off, and lake levels.

In his chapter on the main rainfall fluctuations he makes predictions of future precipitation based on the smoothed curves of previous precipitation.

The various chapters give evidence of painstaking efforts to collect data from all available sources, and the discussions of the data and their significance show careful thought and accurate reasoning. His conclusion that, owing to differing topography and location relative to storm tracks, each sub-area has its own distinctive trends, is in full accord with the results of a study made by the writer of rainfall trends in the central Sierra Nevada and across northern Nevada to the Salt Lake area.

His discussion of the factors other than seasonal precipitation which affect tree-growth is particularly illuminating, showing that in exceptional cases of poor seasonal distribution, or other unfavorable circumstances, the size of the tree rings is not a dependable index of annual precipitation.

In the opinion of the writer, however, there is no proper scientific basis for the methods used in attempting to forecast precipitation trends for a few years in the future. In the first prediction, sections of the smoothed graphs of all the regional summary plots after 1886 are used. The sections are superimposed and the mean taken. The third section, being six years shorter than the others, is extended from 1934 to 1940 by the weighted average of the two earlier curves. In the second prediction, three 16-year sections of the combined graph, somewhat similar in trends, are superimposed and the average curve drawn. Starting with the termination of 1934, the end of the last curve, this average curve is repeated as a forecast of the probable trend for the succeeding 16 years.

In making the predictions, sections of the combined graph after 1886 only are used, the earlier portion 1868 to 1890, described as a "climax interval" not being considered "because it differs from the comparable later ones in its longer duration and in having two secondary maxima." But if the earlier portion of the graph is based on equally reliable data, is it not as likely to be repeated as any later portion? Is it not at least equally probable that after a certain type of graph has been repeated three times, the trend will be along different lines? The trend from 1868 to 1890, it appears has not been repeated, and knowing the irregular manner in which wet and dry years alternate in this region, the number of each in succession varying from one to seven, it does not appear that the assumption of the approximate repetition of any particular section or sections of a precipitation graph is a reasonable basis for a forecast of a future trend.

Aside from the doubtful value of the forecasts, the book is entitled to high praise as representing painstaking collection, compilation, and discussion of a vast amount of widely scattered climato-

logical data and assembling them into a coördinated whole, and is a distinct addition to our knowledge of the factors of tree ring growth through the studies of such growth in the Susanville and Lakeview areas.

GEO. V. SAGER

PEAKE, ORA BROOKS. *The Colorado Range Cattle Industry*. 357 pp., illustrations, maps, and bibliography. Published by The Arthur H. Clark Co., Glendale, California, 1937.

This painstakingly prepared presentation of the history of the range cattle industry in Colorado should be brought to the attention of the geographer and deserves a place on the shelves of his reference library. Though Professor Peake is an historian, and his emphasis is not that of the geographer, yet his discussion is directed toward many problems worthy of the geographer's consideration. In effect Peake is holding a magnifying glass above one of the segments of the western range area, allowing the reader to see, at closer hand and in greater detail, certain of the significant features of western development sketched in a more general way in Webb's invaluable portrayal of the history of the Great Plains (Webb, Walter Prescott, *The Great Plains*. Boston, 1931).

The selection of the state of Colorado for such an intensive investigation of the cattle industry is clearly a fortunate one, since that state, lying astride the continental divide, includes within its borders three large and very different representative types of the western range: (1) the semi-arid grasslands of the Great Plains; (2) the high mountain pastures of the southern Rocky Mountains; and (3) the arid plateau lands to the west. Though his definition of the varied problems associated specifically with each of these sections is not always as clearly emphasized as the geographer might wish, yet the contrasts in the chains of development in them are shown.

The pertinency of the book certainly reaches well beyond the borders of Colorado, for from the very earliest years, when cattle trails from Texas led across the eastern portion of the state, Colorado has been situated in a central location within the range region. As Peake says of these early days when the cattle trailed through the state to its ranges and to those farther north: "These passing through the commonwealth brought Colorado cattlemen into close relationship with stockmen of other states. Thus a range problem in any section of the country became a Colorado problem." Inversely it may be said that the range problems in Colorado simply reflected the range problems elsewhere.

Not only does the discussion throw many interesting lights on the range development as a whole, but it emphasizes how very basic the cattle industry has been in the economic development of Colorado as a state. So near to the roots of the life of this commonwealth was the cattle industry, that the author delights in a portrayal of the days, as late as 1884, when cattle in large numbers still roamed the streets of Denver—the "Queen City of the Plains"—in search of forage.

The book is divided into six chapters. The first two deal with the stocking of the state and the inordinate number of difficulties associated with the Indians and their removal from range lands. The threads of development are picked up in the middle of the last century when the cattle industry was stimulated by the influx of "Fifty-niners" and the advent of the Civil War.

The third chapter deals with the manifold difficulties of securing land for the cattle industry. Such matters as the federal land acts effecting cattlemen, the fencing and the problems of managing the public domain, the use made of the National Forests by cattlemen, are all treated in considerable detail.

In the fourth chapter the author describes at some length the relation of stock associations to the range industry. The directional effects that these local, district, state, and national livestock associations had are of real significance, and the introduction of a study of their influence suggests a somewhat unique approach to certain phases of the whole range problem. The fact that the national livestock association was organized in Denver gives added interest to the author's approach.

The final two chapters of the book deal with Colorado cattle ordinances and regulations, and with the various activities surrounding the marketing of the range cattle. Of no inconsiderable interest in the latter connection is the growth and development of transportational facilities adequate to handle the western stock.

Adding to the value of the book is a very complete bibliography which would be of great service to anyone interested in the part played by the range cattle industry in the whole of western economy.

JOHN C. WEAVER.

New Sweden Tercentenary Publications. By many authors. A series of volumes dealing with economic, social, political, and other cultural developments in Sweden. Published by several presses, 1938, by order of the Swedish Government, or quasi-official bodies.

In commemoration of the landing and settlement on the Delaware of the first Swedish colonists to America in 1638, the Swedish Government, and semi-official organizations under the authority of the government, has published a valuable series of volumes dealing with many phases of Swedish economic and social life. The American Tercentenary Committee also issued a similar publication, but in one volume, entitled *The Swedes in America*, a rather exhaustive and detailed summary of the activities and achievements

of the Swedish-Americans in their new homeland. The latter volume will serve to acquaint the Swedish folk with the progress their American kinsmen have made in the arts and sciences, in industry and agriculture, in politics and education, in war and in peace. The former series of volumes is intended to acquaint all the folk of America, including those of Swedish-American ancestry who are more or less ignorant of the developments in the old country, with the achievements, the progress, and the condition of Sweden and its people. The two publications complement each other.

Not all the New Sweden Tercentenary publications are of geographic significance, but three in particular have greater or less value for the geographer: *The Sweden Year-Book for 1938; How Sweden Overcame the Depression*, by Arthur Montgomery; and *The Forests of Sweden*, by Thorsten Streyffert. While of great significance in interpreting conditions in Sweden, and for that matter in all Scandinavia today, the other volumes do not bear so geographic a meaning. Some of the other volumes which have appeared, and which reveal the extent and character of the series are: *Social Work and Legislation in Sweden*, by The Royal Social Board; *Education and Scientific Research in Sweden*, by Fr. Sandberg and Börje Knös; *Swedish Contributions to the Development of Plant Breeding*, by Åke Åkerman, I. Granhall, G. Nilsson-Leissner, A. Müntzing, and O. Tedin; *Architecture in Sweden*, by August Hahr; and *The Nobel Prizes and Their Founder, Alfred Nobel*, by Fritz Henriksson.

The Sweden Year-Book for 1938 includes, not only the usual material found in a yearbook relating to the government, the finances, the law, the church, the population, the opportunities for travel and entertainment, and so on, but a great deal of geographic material which constitutes a brief but compact geography of Sweden. The major administrative units of the country, the distribution of the population, the natural resources, the most active industries, the trade, both import and export, and social conditions, in Sweden are all treated, not exhaustively, but with considerable detail. Particular attention is given to forests, to agriculture, to industry and mining, and to foreign shipping. Sweden as a tourist country, with a careful discussion of the important travel routes, is given a great deal of attention, and the regions where attractive and interesting scenery and life may be observed are briefly described.

Swedish art, and the collections, museums, and libraries in which it is found; industrial arts and crafts; architecture, literature and music; broadcasting and the press; and physical training, all important features of Scandinavian life, are summarized. Academies and learned societies, industrial institutions and associations, national defense provisions, and numerous other important factors in the life of the people are discussed.

Perhaps the most valuable feature of the yearbook for 1938 is a bibliographical list of books in English on Sweden, and literary works translated into English from Swedish. The bibliography extends over 35 pages of small type, and represents practically every publication available in the English language on the Swedish land and people.

Arthur Montgomery's *How Sweden Overcame the Depression, 1930–1933* represents one of the clearest, fairest, and most convincing statements of the means and methods by which Sweden, and to almost the same extent, the other Scandinavian countries, faced and overcame the world depression that has appeared in this country. A careful study of the governmental policies involved, and the way in which the financial and economic program was shaped to meet the emergency, leads to the feeling that if America had followed a similar policy and program, our country would long ago have been out of the difficulty in which it still finds itself. Mr. Montgomery who writes from The Stockholm Institute for Economic History, opens his study with an account of the economic tendencies in Sweden before the war, explains the consequences of the great war and the deflation crisis in 1920–1922, analyzes the industrial expansion immediately following up to the crisis of 1929, and then considers the steps taken to relieve the financial situation, unemployment, and dwindling trade, and concludes with a résumé of the growth of business prosperity after 1933. It is a most valuable publication.

Because the forests of Sweden have become one of her most valuable sources of income and foundations for industry and employment in the last quarter century, Thorsten, Streyffert's *The Forests of Sweden* attains a significance and value for geographers that many of the other volumes of the series do not. This volume is essentially economic geography, minimizing silviculture and emphasizing the relationships of the forest resources and industry to the environment on the one hand and the economy of the country on the other. It too is a most valuable book, probably the most valuable in the series for the geographer.

The whole series is printed on good paper, in clear type, and by expert craftsmanship. Though bound in paper covers and consequently not so satisfactory for library purposes, the series should be included on the shelves of every library among the educational institutions of our country where regional, economic, or social geography is taught, or where economics and sociology form a part of the curriculum. It constitutes a valuable reference for the traveler, the layman, or the statesman. It will be many years before another such series is likely to appear.

W. ELMER EKBLAW

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Areal Distribution of Manufacturing in the United States, Clarence F. Jones, Clark University, Worcester, Massachusetts.
Tobacco Growing in Southwestern Ontario, Bert Hudgins, Wayne University, Detroit, Michigan.
Depletion in New England Fisheries, Edward A. Ackerman, Harvard University, Cambridge, Massachusetts.
Population Distribution in Newfoundland, Earl B. Shaw, State Teachers College, Worcester, Massachusetts.
Recreation Industry of New Hampshire, Albert S. Carlson, Dartmouth College, Hanover, New Hampshire.
Iron and Steel Industry of Scunthorpe, University of Bristol, Bristol, England.
Gypsum and Salt Mining in Central Hupeh, China, J. E. Spencer, Shanghai, China.
Transportation in the Dominican Republic, William Van Royen, The University of Nebraska, Lincoln.
Communities in the Salt Lake Basin, Albert L. Seeman, University of Washington, Seattle.
Sugar Region of el Mante, W. A. Browne, East Carolina Teachers College, Greenville, North Carolina.

April includes:

Agricultural Gradients in Southern Ontario, J. R. Whitaker, University of Wisconsin, Madison.
Economic Geography of Trans-Jordan, E. Ray Casto and Oscar Dotson, Emory and Henry College, Emory, Virginia.
The Black Forest: Its Human Geography, Alice F. A. Mutton, Queen Mary College, University of London, England.
Trends of Philippine Sugar Production, Alden Cutshall, Ohio State University, Columbus, Ohio.
Agricultural Problems in Grainger County, Tennessee, Robert M. Glendinning, University of California at Los Angeles, and E. N. Torbert, Tennessee Valley Authority, Knoxville.
Prince Rupert, British Columbia, John Q. Adams, University of Missouri, Columbia.
Otomi Indians of Mesquital Valley, Hidalgo, H. C. Lanks, Jenkintown High School, Jenkintown, Pennsylvania.
Manufacturing Districts of the United States, Alfred J. Wright, Ohio State University, Columbus.
Sponge Industry of the Caribbean Area, George S. Corfield, State Teachers College, Duluth, Minnesota.

January includes:

The Italian Beet-Sugar Industry, C. J. Robertson, Institut International D'Agriculture, Rome, Italy.
Agricultural Pattern of East Lothian, Scotland, G. Donald Hudson, Tennessee Valley Authority, Knoxville, Tennessee.
Swine Industry of Denmark, Earl B. Shaw, State Teachers College, Worcester, Massachusetts.
Transhumance in the Land Economy of Schächenthal, Franklin C. Erickson, University of North Carolina, Chapel Hill, North Carolina.
Industrial Development of New Albany, Indiana, Harold V. Miller, Tennessee Valley Authority, Knoxville, Tennessee.
Dark-Fired Tobacco Region of the North Highland Rim, W. A. Browne, Stephen F. Austin State Teachers College, Nacogdoches, Texas.
Urban Population of Palestine, E. Ray Casto and Oscar W. Dotson, Emory and Henry College, Emory, Virginia.
Geographical Aspects of Farming in the Vale of York, H. B. Hodgson, Bradford (Yorks), England.
Erosion Conditions in Grainger County, Tennessee, Robert M. Glendinning, University of California, Los Angeles.
Functional Areas in Political Readjustment, Charles M. Davis, University of Michigan, Ann Arbor, Michigan.
Climate and Crop Isopleths for Southern Ontario, Griffith Taylor, University of Toronto, Toronto, Canada.
Sand and Dust Storms in Vicinity of Lubbock, Texas, Raymond Sidwell, Texas Technological College, Lubbock.
Forest Situation in the Pacific Northwest, Willis B. Merriam, Eastern Washington College of Education, Cheney, Washington.

The October issue of Volume 13 includes:

Competition for the Ocean Trade of Los Angeles, Willis H. Miller, Sacramento, California.
Regions and Resources of Alaska, Albert L. Seeman, University of Washington, Seattle.
Municipal Water Supplies of New England, Carol Y. Mason, Milwaukee-Downer College, Milwaukee, Wisconsin.
Land Utilization in a Glaciated Mountain Range, Celia K. Atwood and Wallace W. Atwood, Jr., Clark University, Worcester, Massachusetts.
Land Utilization in North Park, Colorado, Charles M. Davis, University of Michigan, Ann Arbor, Michigan.
Soils Factor in the Character of Land Use in the Tennessee Valley, J. Sullivan Gibson, State Teachers College, Livingston, Alabama.
The Potato Industry in Minnesota, Asbjorn Fause and George S. Corfield, State Teachers College, Duluth, Minnesota.
Geography of Glass Manufacture at Toledo, Ohio, Walter G. Lezius, University of Toledo, Toledo, Ohio.
Water Power and Economy of La Riba, Spain: An Outlier of Catalan Industry, E. H. G. Dobby, London, England.
City Retail Structure, Malcolm J. Proudfoot, Department of Commerce, Washington, D. C.

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